

PC PRO

Switch to the world's best satnav

And it's not Google Maps p32



DITCH YOUR ISP'S ROUTER



**8
BETTER
ROUTERS
ON TEST**

Triple your speed & destroy dead spots

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9 lessons from tech
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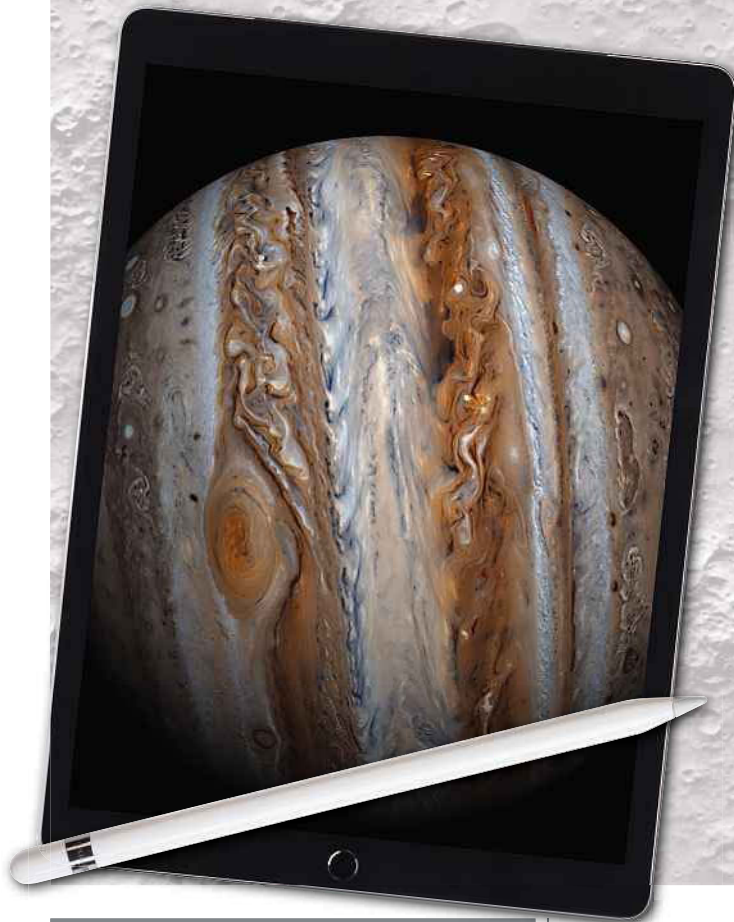
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Editor's letter

Make that idea happen

LIKE ANY Doting father, I don't have a favourite article in this month's *PC Pro*. That would be deeply unfair to, say, our brilliant group test of routers: if you're with BT, TalkTalk, Sky or Virgin, turn to p74 and find out not only which router to switch to, and how to do it, but also how to get more from your existing router if you choose to stick with the model you're supplied by your ISP.

Likewise, the insight into contributing editor Davey Winder's life as he details the fun he had converting a camper van into a truly mobile office (p42). That's without even mentioning the exhausting hours Dave Stevenson put into road-testing the many different alternatives to Google Maps, as he tried to figure out whether you're better off paying for satnav or choosing an entirely different freebie. Discover for yourself, without so much as a three-point turn, by turning to p32.

They're all lovely pieces, but – oh, hang on, now I have Jon Bray, our reviews editor, hissing in my metaphorical ear about the Huawei Watch, iPad Pro and Samsung Gear VR, all of which grace a packed section this month. Happy now Jon? No, he's not. Okay, we also review a £200 laptop, gorgeous Android tablet and a blisteringly fast PC.

So, as I was saying: they're all lovely features, but there may just be one that is more equal than the rest. I talk of Nicole Kobie's inspiring article that digests the wisdom of the UK's most successful tech entrepreneurs and squeezes it into four pages of pure inspiration.

Perhaps I'm biased. The idea of working for myself, creating my own business, has long been a siren call. It's just one that I've dialled down into background noise. Every few months, though, it swells up into a full-grown wail, because there are just so many benefits. Working for

myself, not for the man. Creating something amazing with the support and help of a team of others (especially should something go wrong, when they're definitely getting the blame). Turning an idea into a product or service that people are actually willing to pay for.

I'm not alone, I know that. There's a reason *PC Pro*'s bestselling MagBook of all time is called *How to set up an Online Business*, now in its seventh edition (and, yes, on sale at Amazon for £9.99). Indeed, I remember reading the first draft chapters, way back in 2009, and thinking to myself: "Come on, Tim, you should do this." Especially as one piece of advice is that you needn't give up your day job. It's just that, immediately afterwards, I was struck by what an excellent idea it would be to have a nice cup of tea and a biscuit first. It was a big cup of tea.

But enough excuses. It's time to take inspiration from Eben Upton, the man behind the Raspberry Pi, who says: "You've got to think that you're going to accomplish something that's worthwhile." And Blippar co-founder's Jess Butcher's words: "Don't let yourself be overwhelmed by the task ahead and use that as a reason not to start."

I won't, Jess, I won't. After all, as Huddle's Alastair Mitchell points out, you must ask yourself what regret will haunt you just before you're struck by a big red bus. It's highly unlikely you'll congratulate yourself on your tea consumption.

Tim Danton
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Ivan Pope 3D printing has grabbed the mainstream media's attention, but Ivan has spent years working out how to create a business based on 3D scanning. See p116



Nicole Kobie While Paul extols smart home benefits, Nicole interviews a security researcher who explains why internet-connected kettles aren't such a good idea. See p126



Paul Ockenden Enough about smartwatches: Paul's been spending time with automation gizmos that have convinced him smart homes are here to stay. See p113



Nik Rawlinson Got a webcam gathering dust? It might just be the vital ingredient of your own security camera setup. Nik explains how to make it work on p50



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What piece of tech would you like for Christmas?

"A pro-quality 27in monitor, please – the Eizo ColorEdge CG277 will do nicely."

"A self-driving car. It's got to be safer than my own bleary efforts behind the wheel."

"An iPad Pro. At last Apple has made the iPad I've always wanted."

"A new Kindle to replace the one I've had for the past six years. The best bang for buck I've ever had from a piece of tech."

"A fuel cell battery to recharge my devices – but a good one that works."

"A jetpack, because 50 years ago they promised that I'd have one by now."

"A smartwatch that I'd want to wear..."

"Same as 'Last Christmas', another Sonos speaker, because I can't think of anything worse than a 'Silent Night'."

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Briefing



Background and analysis on all the important news stories

The future of the PC market
2016 could see more PC makers
shutting their doors **p12**

The new Snoopers' Charter
What does the draft bill mean
for you and your business? **p14**

PC Probe
Are tablets heading the
same way as netbooks? **p16**

Will ISIS turn to hacking?

The government has doubled its online security fund to prevent infrastructure attacks from terrorists – and it's getting help from Anonymous



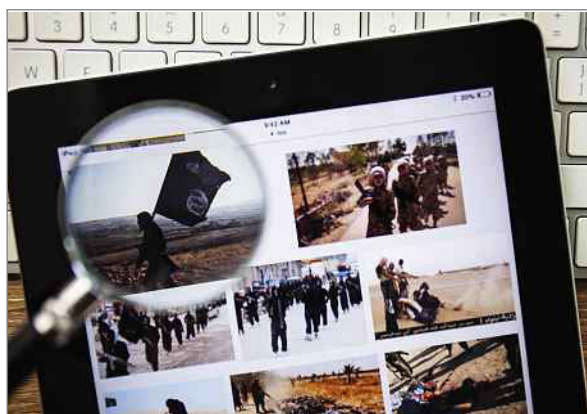
SHOULD WE BE scared of ISIS when surfing the web? Chancellor George Osborne warned in a speech that ISIS terrorists are developing the hacking skills to attack hospitals, air-traffic control and other key infrastructure.

He told parliament that “the stakes could hardly be higher” as he announced the government was doubling its online security crime-fighting fund to £1.9 billion over the next five years. “If our electricity supply, or our air-traffic control, or our hospitals were successfully attacked online, the impact could be measured not just in terms of economic damage but of lives lost,” Osborne warned.

“They do not yet have that capability,” he said of the terrorist group. “But we know they want it, and are doing their best to build it.”

Could cyberterrorism really be as dangerous as Osborne predicts? “I’d like to say no,” said Sean Sullivan, an analyst for the security company F-Secure. “Unfortunately, there are numerous control systems online that probably shouldn’t be.”

ABOVE It's unlikely that Anonymous will be able to do ISIS any real harm



ABOVE Sean Sullivan is an analyst at Finnish security company F-Secure

That doesn't mean that the militants training in Syria and Iraq are learning the finer points of network penetration, though. “ISIS almost certainly doesn't have the ability to hack critical systems,” Sullivan said. “But they might not need to when they can instead phish somebody with access.”

As with any terrorism campaign, it's an asymmetrical fight. ISIS only needs to get lucky once to succeed, meaning that “it's difficult to say what the government can really do,” said Sullivan. However, he added it “does seem to be a mistake to allow ISIS to go unchallenged” online.

Sullivan suggests that Western governments should be fighting back against the terrorists. “Propaganda accounts have probably been useful until this point for intelligence analysis, but now it would seem to make greater sense to attempt takedowns [of Twitter accounts and the like],” he said. “Allowing ISIS to continue to have an online presence plays into its hands.”

■ Anonymous battle

The government isn't the only organisation planning to tackle ISIS online: the loose collection of

“It’s possible that Anonymous could end up doing themselves more damage than the terrorists”

hackers and digital troublemakers known as Anonymous pledged to attack the terrorists’ online presence, saying it was “at war” after the horror unleashed on the streets of Paris in November.

Sullivan isn’t convinced that the hackers can do ISIS any significant harm. “Anonymous has published ‘hacking’ instructions – information that amounts to little more than how to search for and report on propaganda reports,” he explained. “It will be an endless game of whack-a-mole.”

It’s possible that Anonymous members could actually end up doing themselves more damage than the terrorists. Junaid Hussain, a former teen hacker from rival group TeaMpoison, served six months in prison for hacking into the address book of Tony Blair. Last year, with “nothing to lose”, he travelled to Syria to join ISIS and was killed this August by a US drone strike.

“UK officials would serve the public better if they were to use the criminal justice system to reform and recruit ‘hacking’ talent rather than to punish and isolate,” Sullivan said. “It would cost far less money.” ●



BELOW George Osborne warned that ISIS are learning to hack

Five stories not to miss



1 Sky warns on porn extortion letters

Sky customers may receive a demand for money from rights firm Golden Eye for illegally downloading pornography, and the ISP has warned users to read the letters carefully. Golden Eye has a court order to get details of Sky users and ask for payments, similar to previous “speculative invoicing” cases – none of which made it to court.



2 Microsoft releases Threshold 2 for Windows 10

Windows 10 has received its first major update, dubbed Threshold 2, promising a performance boost, a fresh version of the Edge browser and handwriting recognition for Cortana. However, those installing the upgrade reported glitches, with some users reporting that the process stalls halfway through on devices that have an SD card in the slot.



3 Google’s driverless car pulled over by police

California police pulled over Google’s test autonomous vehicle for driving too slowly. The cars are limited to 25mph while they’re being trialed, unbeknown to the Mountain View Police Department officer. The Google car was let off without a ticket, preserving the spotless record of Google’s fleet of self-driving vehicles.

4 Leak suggests Samsung making a smart flip phone

Remember flip phones? They may be making a comeback. Leaked photos suggest Samsung is making a clamshell model based on the Galaxy S6, possibly with dual displays. If that sounds like a surprising throwback to 2005, it’s actually not the first flip phone Samsung’s made in the recent past – it released a similar model in Korea over the summer.



5 Sky reinvents on-demand with Q

Sky unveiled the long-awaited successor to Sky+. The Q system includes a set-top box that can record up to four programmes simultaneously at 4K resolution; extenders that beam recorded content to other TVs in the home and boost Wi-Fi coverage; and the ability to watch recorded shows on tablets and phones when away from home.



THE RESULTS SPEAK FOR THEMSELVES



Predicting the future of the PC market

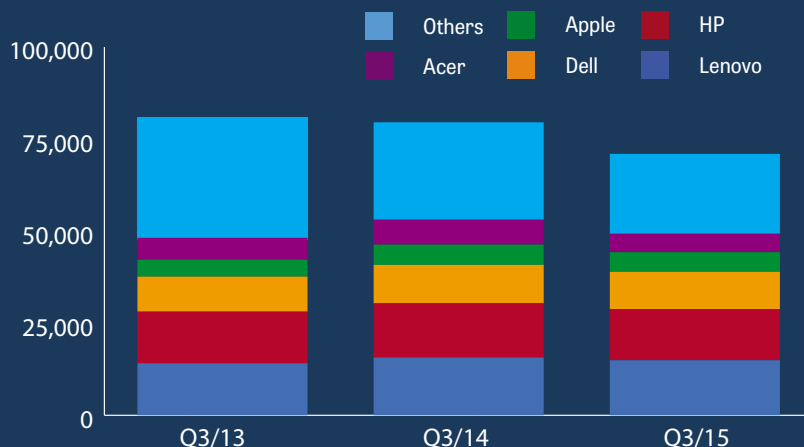
Computer sales continue to slide. While 2016 may see a rebound, it may also see more PC manufacturers shutting their doors

PC shipments

Two of the top ten PC makers will close in the next two years. That's the prediction from IDC analyst Tom Mainelli, and while we'll have to wait and see if his forecast is accurate, there's no question that the PC market is struggling.

Windows 10 hasn't helped much, as most users simply installed the free upgrade rather than shelling out for new hardware.

While the top four manufacturers all saw their sales slide last year, Mainelli predicted that the two manufacturers to suffer would be further down the rankings – ominous for the likes of Acer, Toshiba and Samsung. Indeed, the latter has already stopped selling laptops in Europe, while in 2014 Toshiba said it would “withdraw from unprofitable markets”.



The future of Acer

Acer will be feeling the slight from Mainelli's comments: it's the fifth-ranked PC seller, so his prediction that the top four would survive is pretty damning. You need not

look hard to see why, though. While founder Stan Shih told Chinese newspapers that “Acer will not by any means exit from the market”, he has previously suggested the firm would “welcome” a takeover bid.

However, Mainelli made it clear his prediction doesn't include acquisitions, as the top-ranked PC makers don't gain much from buying anyone from the bottom of the list. Again, ouch.

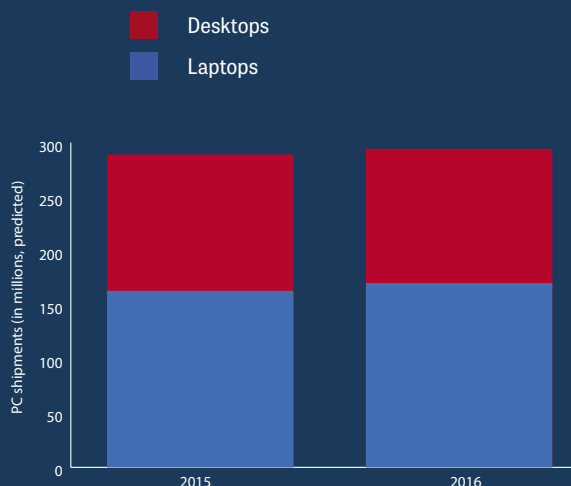


Stable sales

None of this means the PC market is dying, merely settling into middle age. PC sales will essentially be flat over the next five years, IDC predicts, with laptop sales growing by 1.2% and desktop sales sliding by 0.6%.

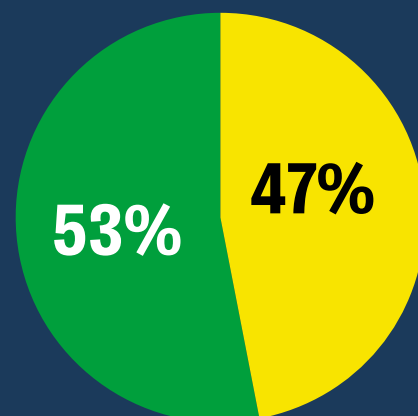
Desktops will see stronger sales in emerging markets than elsewhere, while laptop will still be favoured by those in mature markets, which suggests a decision to stop selling desktops in over-saturated developed regions may not be the worst call for troubled PC makers.

Predicted PC sales



Sales divide between mature and emerging

Emerging markets
Mature markets



What is... Anywhere SIM?

The UK is covered in mobile not-spots, but one mobile virtual network operator has stepped up with a solution

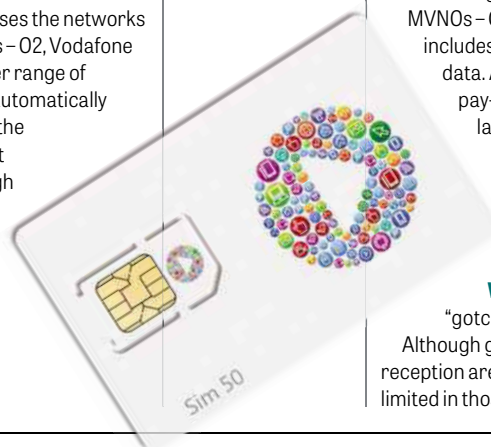


Live in a rural area or in a solidly built house in the middle of the city? Then you probably know the pain of mobile not-spots – when lack of coverage means dropped calls and no mobile broadband. However, there's a secret that mobile operators don't want you to know: they could easily allow you to hop onto a rival's network to get coverage. That's called national roaming, and the government last year attempted (and failed) to force the big operators to allow that on 2G networks. Thankfully, a new player has stepped in with its own solution. Here's how the Anywhere SIM could help solve your coverage woes.

Anywhere SIM? Sounds a bit like Everything Everywhere. The 4G tie-up between T-Mobile and Orange was indeed known as Everything Everywhere before rebranding as EE, but that's where the similarities end – and we don't expect Anywhere to rename itself "A" any time soon, either.

Unlike EE, Anywhere is a mobile virtual network operator (MVNO). That means it piggybacks on other networks, using their infrastructure to offer mobile services. Anywhere is hardly the first: Tesco Mobile, Giffgaff and other discount operators are all MVNOs.

So this is another Giffgaff? There's one big difference. While Giffgaff uses O2's infrastructure, Anywhere uses the networks of three different operators – O2, Vodafone and EE – giving users a wider range of coverage. Your phone will automatically switch to the network with the strongest signal, although it can't switch midway through a call – you'll have to hang up and redial if you wander into a low-coverage area. It can also roam across the EU, and the company is promising it will soon work beyond Europe, too.



How can Anywhere offer national roaming if the big players are against it?

The clever folks at Anywhere have teamed up with Manx Telecom from the Isle of Man. It's an MVNO using O2's network, but it also has roaming deals with EE and Vodafone.

Why isn't anyone else doing this? We could all have improved coverage if only the big providers would allow it, but in the meantime there are other options. Telecoms firm Jump, from 24 Seven, offers a national roaming service to businesses and is planning a consumer launch soon, while UK ISP Andrews & Arnold has an MVNO that uses O2, but can offer national roaming via a deal with Vodafone in the Netherlands.

“ Anywhere can roam across the EU, and the company is promising that it will soon work beyond Europe, too ”

What's the cost?

If you want the coverage offered by national roaming, you'll have to pay for it. Anywhere has three main plans, all offered pay-as-you-go with no

set plans. The Anywhere Home SIM lets you receive calls from any available network, but everything else is done over O2. Calls cost 5p per minute and data 5p per megabyte.

The Anywhere UK SIM includes national roaming for 10p-per-minute calls and 10p/MB data, while the top-tier option with European roaming included costs 12p per minute for calls and 10p/MB for data.

Those charges are all more than other MVNOs – Giffgaff has a £10 SIM that includes 500 UK minutes and 1GB of data. Anywhere has said that a pay-monthly option will be available later this year, and users will have the option to upgrade to such a plan for free. You can buy a SIM from the website at anywheresim.com.

What's the catch?

The biggest “gotcha” is no 4G data, only 3G. Although given this is for people in weak reception areas, access to 4G is likely to be limited in those regions anyway. ●

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Snoopers' Charter: what it means for your business and broadband bill

The government has unveiled a draft of the Investigatory Powers Bill. **Nicole Kobie** reveals what it means for you – and the changes its critics hope take place before it becomes law



IT'S BACK: the so-called Snoopers' Charter has returned, this time in the form of the Investigatory Powers Bill, giving security services the power to force backdoors into tech companies' encryption, sift through our web-browsing logs and hack targets.

The bill is only a draft and could be subject to many amendments before it becomes law, but this time the Liberal Democrats no longer have the requisite number of MPs to block the bill's progress, as they did last time in coalition. Here's the lowdown on the potential impact of the legislation as it stands.

■ What does the bill include?

If passed, these laws would require internet service providers (ISPs) to log every website Britons visit, as well as collecting communications metadata (such as who you Direct Message on Twitter), but not the actual content of the messages. ISPs would then be required to share this data with the security services as part of an investigation concerning national security or serious crime.

It also introduces measures to allow authorities to hack computers, bug phones, and require companies to help them do so. For the first time, the bill also includes a commissioner for oversight, with some aspects requiring judicial approval.

■ What's different from the previous version of the Snoopers' Charter?

Dr Paul Bernal, lecturer in IT and media at the University of East Anglia School of Law, told *PC Pro* that the new bill is more "comprehensive" than the previous version, the Communications Data Bill (CDB), with the notable additions including "equipment interference" – which is the government's "euphemism for hacking" – and bulk data collection.

Jim Killock, executive director of the Open Rights

ABOVE The laws proposed by the government would require ISPs to log all of the sites we visit

Group, noted another key difference. "Some of the contentious proposals from the CDB are not included, for example, forcing communication service providers to collect third-party data," he told *PC Pro*. "However, it would oblige telecoms companies and ISPs to collect data about the websites their customers visit and keep it for a year. The police could access this data through a filter, which was one of the proposals in the CDB."

■ Should we be concerned?

Website logging has raised the most concerns. "Keeping a record of the websites that everyone has visited is an unprecedented step," said Killock. "It doesn't happen in the US or any EU or Commonwealth country, and we don't think it should happen in the UK. We would like to see these proposals dropped."

Bernal agreed. "Our browsing history really



Draft Investigatory Powers Bill

Presented to Parliament
by the Secretary of State for the Home Department
by Command of Her Majesty
November 2015

should remain private unless there's a very good and specific reason to collect it," said Bernal. "The risks here are huge and not properly admitted: this is nothing like the 'itemised phone bill' mentioned by [home secretary] Theresa May at all, but a record of pretty much our entire online life."

Nigel Hawthorn, marketing director of cloud security firm Skyhigh Networks, noted that this data could leave us less safe. "My greatest concern with the draft bill is that logging internet traffic could act as a honeypot to criminals trying to find information that can be used for extortion," he told *PC Pro*. "The recent TalkTalk hack shows that ISPs don't always have the best data security, and a worrying, albeit unintended, consequence of the bill could be that more public data falls into the wrong hands."

■ What's the good news?

However, Bernal said that the bill isn't "irredeemable". Although there are changes he'd make, one benefit of the bill is the "acknowledgement, at least to an extent, of what they are doing".

Increased oversight – with a commissioner tracking surveillance and data requests, and the new requirement for judicial review – is an improvement over previous versions of the Snoopers' Charter.

While it's a start, Killock believes that these oversight controls should be even tougher. "The home secretary [Theresa May] claimed that the bill will introduce judicial authorisation to some surveillance warrants, which would mean sign-off by a secretary of state and a judicial commissioner," he said, rather than simply requiring May's approval, as is currently the case. "However, in reality, the judicial commissioner would only be signing off on the process, not on whether surveillance is justified. This, in effect, would be a rubber stamp, not



ABOVE Encryption won't be banned by the bill, and backdoors won't be placed in software

authorisation. Judicial authorisation needs to be much more rigorous."

■ What does it mean for encryption?

Encryption isn't explicitly banned, which many were expecting. "I'm pleased that the trailed attack on encryption or the placing of backdoors into software is not part of the bill," said Hawthorn. "Many in the tech industry feared the worst, and it's good to see that the government

listened to input on this matter."

However, there are still sections of the bill that could force companies to provide access to data on a case-by-

“ Logging internet traffic could act as a honeypot to criminals trying to find data to use for extortion ”

case basis. "The bill asks for powers to compel communications providers to assist with demands for interception," said Killock. "In some cases this might involve compromising their software to make the encryption less effective. This is something that we're sure companies will be looking into."

Any company that receives such a warrant would be unable to disclose it, meaning it could become difficult to trust your service provider or be

sure that their encryption doesn't have hidden holes.

■ What will my business have to do?

Nothing, hopefully. Under the plans, the government could ask you to take measures to make data available, but there's no blanket requirement unless you're an ISP. Other than that, Hawthorn said he doesn't "see it having a huge impact". He added: "The bill will only affect a really small percentage of UK tech companies and nominally so."

■ Will my broadband bills increase?

Yes, according to ISPs themselves. The government has budgeted £175 million to pay for storing communications and browsing data, but ISPs told a parliamentary committee that the total bill would be much higher – and reflected in broadband bills.

Matthew Hare, CEO of broadband provider Gigaclear, told MPs that a typical gigabit connection passes 15TB of data per year. The content must be sifted from the so-called metadata, which then needs to be secured and stored. "The indiscriminate collection of mass data is going to have a massive cost," he said.

■ What can I do to prevent the bill from passing?

Submissions to the government's Science and Technology Committee closed in November, but you can still influence the Investigatory Powers Bill by writing to your MP or supporting activists such as the Open Rights Group. The bill is in the draft stage, so the government expects to make changes as it's debated next year, before coming into force in 2017. "The bill will change the relationship between the state and its citizens for the next generation – it's vital that we scrutinise these powers thoroughly," Killock added. ●



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PC Probe

Tablet crash: what will happen next

Tablet sales have been in decline for some time. Are slates heading the same way as netbooks? **Stuart Andrews** investigates

There's no doubt that tablet sales are now in the doldrums. Recent research from IDC claims that tablet sales have fallen 7% between the second quarter of 2014 and the same period this year. That statistic is echoed by research from Forrester that suggests the global tablet market has plateaued. Furthermore, a July report from ABI Research puts tablet sales in the first quarter of 2015 down 13% on sales in Q1 2014.

The two market leaders, Apple and Samsung, are struggling most: iPad sales are down 17.9% and Samsung tablet sales down 12%, according to IDC. ABI says the big boys are being hit even harder than that, claiming a 23% decline for iPads and a 30% decline for Samsung. On the other hand, some of the smaller players are growing. Tablets from Lenovo, LG and Huawei are all doing well by competing hard on price.

That said, the signs are worrying. Is the tablet dying, or is the hype just dying down, leaving the tablet to find its natural level?

■ Why are tablets struggling?

When the iPad emerged in 2010, tablets were widely seen as the disruptive force that would herald a post-PC world. By 2011, analysts from Gartner, Forrester and IDC predicted massive sales, with the more excitable ones predicting that tablet sales would eclipse laptop sales by 2015. However, while PC sales remain weak, tablet sales have since fallen into decline. Apple's earnings call for fiscal Q3 2015 showed that the revenue from the iPad business was lower than revenue from the Mac business – the first quarter in several years where this was the case. So why has the tablet seemingly fizzled out?

Analysts generally put it down to three core factors.

1 Innovation has stalled

For the first few years after the iPad arrived, manufacturers went into overdrive in an attempt to outdo the competition with new designs, high-performance components and features. Apple, Samsung, Sony and Amazon brought Retina or Full HD screens into play. Devices became slimmer, with the iPad thinning from 13mm to 7.4mm with the iPad Air. Microsoft's Surface and Surface Pro had click-in keyboards and kickstands, while Samsung

brought in the stylus with the Galaxy Note. Processors moved on from dual-core processors with a basic GPU to quad-core and octa-core processors with the kind of GPU that could have powered a last-generation games console.

However, tablet innovation has now stalled. Screens can't reach higher resolutions without getting bigger or the differences becoming imperceptible. The battery size and need for strong construction make it impossible to become noticeably thinner or lighter. Features such as a stylus or split-screen app view are useful to some, but irrelevant to others. While new processors with even more powerful GPUs are coming on line, there's a dearth of software that really makes use of them. You need high-performance GPUs to play the next *Infinity Blade*, *Dead Trigger 2* or *Real Racing 3*, but tablet users are primarily casual gamers, more interested in the next *Angry Birds* or *Clash of Clans*. These don't require new hardware.

As JP Gownder says in Forrester's "Global Tablet Forecast 2015 to 2018": "The iPad Air 2 compares favourably to earlier generations of iPads: it's thinner, lighter, has a better battery life and boasts a somewhat faster Wi-Fi connection, but are these incremental features enough to entice buyers to spend \$499 to \$829 to replace a still-functional older iPad?"

Hubert Joly, CEO of the US electronics chain Best Buy, made the same point in a recent interview: "The issue has been that, once you have a tablet of a certain generation, it isn't clear that you have to move on to the next generation." That leads us on neatly to our next factor.

2 Users aren't replacing tablets

That's partly because there's no compelling reason to upgrade, and partly because tablets are so robust. A

tablet's product lifetime seems to be much longer than that of a smartphone. This was a point made by Apple CEO Tim Cook in an earnings call this summer: "The upgrade cycle is longer," he said of the iPad. "It's longer than an iPhone, probably between an iPhone and a PC. We haven't been in business

“New processors have more powerful GPUs, but there's a dearth of software that makes the most of them”



ABOVE Google's Project Tango could help revitalise the tablet market

BELOW Battery size and the need for strong construction make it difficult for tablets to go lighter

Reasons to be cheerful

It seems that tablets have little chance against this triple threat, but that doesn't mean that they're in terminal decline either. Longer refresh cycles might mean lower sales, but consumers are still using their tablets and may one day want to replace them. They continue to be a hit with families, too – no other device is as handy, accessible and inexpensive enough to share with your kids.

What's more, tablet use is growing in the business sector. Forrester's research shows that more than half of employees are now using tablets for business at least once a week, often in those situations – while in transit, standing, or for specific workflows – where a laptop isn't such a good fit. And while these workers are bringing their own devices to work under so-called Bring Your Own Device (BYOD) schemes, company-purchased tablets are making up an increasing portion of the market. Expect to see this accelerated by the growth of business-class devices, which was kickstarted by Microsoft with the Surface Pro, but has now been adopted by manufacturers such as Apple, HP, Dell and Samsung. Despite bigger screens and multitasking capabilities, these are still tablets, but the addition of clip-on keyboards or a stylus makes them more versatile productivity devices.

Innovation also has a part to play. We may have seen all the tablet can offer in terms of screen resolution and physical design, but there's still potential for new power-hungry applications to come along, while 3D depth-sensing technologies, such as Intel's RealSense cameras and Google's Project Tango, could revitalise interest in tablets. The hype might be dying down, but the tablet isn't dead. It's no laptop killer, but it has its own niche to fill. ●

long enough to say that with certainty, but that's what we think." Gartner research director Ranjit Atwal concurs: "The lifetime of tablets is being extended – they are shared out among family members – and software upgrades, especially for iOS devices, keep the tablets current," he said in a recent report.

3 They're under pressure from phablets

Just about everyone agrees that tablets are struggling to compete with big-screen phones, and that 7-8in devices are particularly affected. After all, if you're packing a Samsung Galaxy Note 4, an iPhone 6 Plus or a Google Nexus 6, where's the value in carrying around a slightly larger tablet too? "Users of tablets with a screen size between seven and eight inches are increasingly not replacing their devices," suggested Gartner research director Annette Zimmerman.

In fact, a June 2015 Gartner survey found that 44% of current tablet users were planning to substitute their tablets with another device.

"A consumer owning a large smartphone wouldn't see the point in renewing or purchasing a slightly larger device with very similar functionalities," said IDC analyst Marta Fiorentini. "In fact, smartphones have additional voice capabilities and sometimes better cameras or resolution."



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The A-List

The ultimate guide to the very best products on the market today

LAPTOPS

Apple MacBook Pro 13in with Retina display

2015 model, from £999

apple.com/uk

With its innovative Force Touch trackpad, Broadwell processors and the same excellent Retina screen, the MacBook Pro is better than ever. It's fast, with superior battery life to the previous generation, and that trackpad improves all-round usability.

REVIEW: pcpro.link/almacp15



SMARTPHONES

Samsung Galaxy S6

Android, 32GB, free phone, £25/mth, 24mths

uswitch.com

With the Galaxy S6, Samsung has finally created a phone as beautiful as it is capable. Superb performance, a nigh on perfect display and an astonishingly good camera provide the perfect foil to the most attractive Samsung handset yet.

REVIEW: pcpro.link/algals6



ALTERNATIVES

Asus Zenbook UX303LA

The latest Broadwell Core i7 and a quality screen make this Ultrabook both desirable and great value.

£734; handtec.co.uk

REVIEW: pcpro.link/alzb303

Asus C201 Chromebook

NEW ENTRY

It has weak points – the screen is okay rather than great – but the C201 is ideal for life on the move thanks to its outstanding 12-hour battery life. £200; currys.co.uk

REVIEW: see p64

HP Stream 11

Good looking, well built and equipped with a decent display, the petite Stream 11 is as good as it gets for the money. £179;

hp.co.uk **REVIEW:** pcpro.link/alh11

ALTERNATIVES

Google Nexus 5X

An ugly duckling but brilliant where it matters: speed, camera, and the latest Android 6 action. £339; store.google.com

REVIEW: pcpro.link/alnexus5x

Sony Xperia Z5 Compact

If you can cope with a "mere" 4.6in screen, this speedy, slender phone has it all. From free, £25/mth, 24mths; uswitch.com

REVIEW: pcpro.link/alsonyZ5

Apple iPhone 6s

Enthusiasts should upgrade for 3D Touch alone, with extra speed and durability as a bonus. 64GB, from £60, £39/mth, 24mths; uswitch.com

REVIEW: pcpro.link/alapple6s

TABLETS

Apple iPad Air 2

9.7in tablet, 64GB, £479

apple.com/uk

Even faster, even lighter and just as pretty as ever – the iPad Air 2 takes everything that made the original great and improves upon it. Updated cameras and the arrival of Touch ID are welcome upgrades. Its only real rival is the original 32GB iPad Air, now discounted to a tempting £359.

REVIEW: pcpro.link/alipair



ALTERNATIVES

Samsung Galaxy Tab S2 8in

Fast, slim and with a gorgeous 8in display, the Galaxy Tab S2 is as good as compact tablets get.

£360; handtec.co.uk

REVIEW: pcpro.link/alsgts2

Apple iPad Pro

NEW ENTRY

The price is hard to swallow, but you're getting so much more than a tablet. It's fast, beautiful and versatile.

32GB, £679; apple.com/uk **REVIEW:** see p56

Apple iPad mini 2

A price drop due to the iPad mini 4's arrival makes this old-timer more attractive than ever. 16GB, £219; apple.com/uk

REVIEW: pcpro.link/almini2

PCs

Yoyotech Warbird RS10

Base unit, £600

yoyotech.co.uk

This PC offers serious power, thanks to an Intel Skylake Core i5 processor overclocked to 4.4GHz, 8GB of DDR4 RAM and a GTX 960 graphics card. Despite this power, it's quiet in use. An extra £100 will buy a 22in monitor and Zalman mouse/keyboard combo.

REVIEW: pcpro.link/alwarbird



ALTERNATIVES

Apple iMac 21.5in

A classy all-in-one with a compact frame, ample power and a colour-accurate screen. From £899; apple.com/uk **REVIEW:** pcpro.link/alimac215

Apple iMac 27in with Retina 5K display

A new and revamped specification improves Apple's stunning all-in-one. From £1,599; apple.com/uk **REVIEW:** pcpro.link/alretina

Chillblast Fusion Krypton

NEW ENTRY

Eye-catching design is matched with speed, with the GTX 970 card a superfast star.

£916; chillblast.com **REVIEW:** see p62

MONITORS

Asus PB287Q

Premium monitor, £360
dabs.com

Not so long ago, a 4K display for less than £500 was unimaginable. Asus delivers exactly that: a razor-sharp image on a 28in panel at a very reasonable price.

REVIEW: pcpro.link/alpb287q



Eizo ColorEdge CS240

Eizo ticks almost every box with the 24.1in, 1,920 x 1,200 ColorEdge CS240. With a highly colour-accurate IPS screen, it's the first truly professional-class monitor we've seen at anywhere near this price.

£462; wexphotographic.com

REVIEW: pcpro.link/alcs240

AOC Q2770Pqu

A feature-packed, 27in 2,560 x 1,440 display offering a huge workspace, an adjustable stand, a four-port USB hub and a three-year warranty. Super PLS technology gives great viewing angles too. At this price, it's a steal. **£310; dabs.com**

REVIEW: pcpro.link/alq2770

PRINTERS

Canon Pixma MG6450

All-in-one inkjet printer, £113
printerbase.co.uk

The MG6450 inherits its predecessor's status as *PC Pro*'s favourite inkjet all-in-one, offering high-quality output at a very reasonable price.

REVIEW: pcpro.link/almg6450



Canon Pixma iP8750

Canon's mid-range inkjet is ideal for anyone with a fancy for prints larger than the usual A4. It can print photos at up to A3+ in size, and its six-ink cartridges produce immaculate photographs, yet the price isn't extortionate. **£200; currys.co.uk**

REVIEW: pcpro.link/alip8750

Epson Expression Photo XP-950

Epson's high-end inkjet all-in-one is a fantastic all-rounder for the enthusiast photographer. It combines high-quality prints with a decent scanner, a great touch interface and the ability to output photos at up to A3 in size. **£240; parkcameras.com**

REVIEW: pcpro.link/alxp950

ROUTERS

Netgear Nighthawk X4S

802.11ac router, £270 **NEW ENTRY**
broadbandbuyer.co.uk

In return for that staggering price, you're getting top-end performance, today and in the future – thanks to support for multi-user MIMO. Bags of advanced features only add to its attractions.

REVIEW: see p86



Synology RT1900ac

NEW ENTRY

Until now, Synology was known for its NAS drives, but this 802.11ac router suggests it may become a major player here too. Not only fast, easy to use and packed with features, it also comes at a price that undercuts rivals by up to £50. **£115; synology.com/uk**

REVIEW: see p87

Netgear Nighthawk AC1900 Extender

The most powerful wireless extender on the market, Netgear's Nighthawk marries five Gigabit networking ports with fast, dual-band 802.11ac support and a host of features.

£110; currys.co.uk

REVIEW: pcpro.link/alngex7000

HOME NETWORKING

Synology DiskStation DS215+

Network-attached storage, £257
amazon.co.uk

A versatile dual-bay NAS with great support for cloud services, dual USB 3 ports and our favourite web-based management interface. It's speedy and packs a lot into a compact unit.

REVIEW: pcpro.link/alds215plus



Qnap TS-453mini

Superb performance and a decent range of media and server features – including an HDMI output – make this four-bay NAS drive a great choice for both home and business.

£409; ebuyer.com

REVIEW: pcpro.link/alts453mini

Google Chromecast 2

NEW ENTRY

Google's TV streaming device has been improved, finally adding support for 5GHz Wi-Fi. At only £30, it's a no-brainer for anyone looking to beam video from their Android device to their TV.

£30; play.google.com

REVIEW: pcpro.link/alccast2

WEARABLES

Huawei Watch

Smartwatch, £289 **NEW ENTRY**
huawei.com/uk

Android watches are gaining in number and class, as this excellent debutant from Huawei shows. Its super-bright AMOLED display is the star turn, but it's backed up by classy touches throughout.

REVIEW: see p71



Apple Watch Sport

The slickest smartwatch experience there is, thanks partly to the unique scroll-wheel interface and advanced haptic features. The weakness is battery life – expect to charge it every night – and even the low-end Sport model doesn't come cheap.

£299, apple.com/uk **REVIEW:**

pcpro.link/alapplew

Pebble Time

A fun, practical watch that works with both Android and iOS. App support is comparatively limited, but all the fundamentals are covered, and the colour e-paper screen helps the Time achieve five days of battery life. **£180, firebox.com**

REVIEW: pcpro.link/alpebble

SECURITY SOFTWARE

Kaspersky Internet Security 2015

Another year, another excellent performance for this super-secure, lightweight and unobtrusive security suite.

3 PCs/1yr, £35; store.pcpro.co.uk

REVIEW: pcpro.link/alkasis15



Avast Free Antivirus

Still the best free antivirus, although others are catching up. It offers dependable protection – and it doesn't nag you about upgrading. **Free;**

avast.com

REVIEW: pcpro.link/alavast15

Norton Security 2015

A venerable name in security, Norton provides excellent protection and covers up to five devices, including laptops, tablets and smartphones.

5 devices/1yr, £25;

amazon.co.uk

REVIEW: pcpro.link/alnort15

PRODUCTIVITY SOFTWARE

Microsoft Office 2016

We'll be honest: there's very little here for anyone upgrading from Office 2013. However, this is still the best office suite for professional.

From £120; office.microsoft.com

REVIEW: pcpro.link/aloffice16



LibreOffice 5

The interface looks a little dated, and the lack of collaboration features is a shame. But interoperability with Word and Excel is better than ever, making this a fine upgrade.

Free, libreoffice.org

REVIEW: pcpro.link/allibre

Scrivener

A brilliant package for serious writers: not only a word processor, but a tool that helps you organise your ideas and manage the process of composition from start to finish. **£29;**

literatureandlatte.com

REVIEW: pcpro.link/alscrivener

CREATIVITY SOFTWARE

Adobe Creative Cloud

The licensing model won't suit everyone, but Adobe's suite of creative tools keeps getting better, covering everything from photo and video editing to web development.

Complete plan, £46/mth; adobe.com

REVIEW: pcpro.link/alcc15



Adobe Photoshop Elements 14

Despite few new features, this is still the best home image-editing tool around. Consider subscribing to Lightroom and Photoshop proper instead, though. **£60;**

amazon.co.uk

REVIEW: pcpro.link/alelem14

Steinberg Cubase Pro 8

A big bump in performance and a handful of UI improvements keep Cubase at the top of the audio-production tree. A worthwhile upgrade.

£326; dv247.com

REVIEW: pcpro.link/alcubasepro8

SERVERS

HP ProLiant DL80 Gen9

Massive storage capacity combines with a high-speed Xeon E5-2600 v3 CPU and a scalable design to push this HP rack server to the top of the tree. The price is very reasonable as well. **£997 exc VAT; insight.com**

REVIEW: pcpro.link/alhpdli80



HP ProLiant ML150 Gen9

HP's compact tower server packs in a huge range of high-end features, alongside impressive expansion capabilities so it can grow as your business does. A great buy. **£922 exc VAT; insight.com**

REVIEW: pcpro.link/alhplml150

STORAGE APPLIANCES

Qnap TVS-EC1280U-SAS-RP

Hungry for storage? Then take note of this 12-bay 2U NAS, to which you can connect up to eight disk shelves for a total of 140 drives. A 3.5GHz Xeon CPU speeds things along. **Diskless, £3,556 exc VAT; lambda-tek.com**

REVIEW: pcpro.link/alqnaptvs



Synology RackStation RS2416RP+

Built with speed and expansion in mind, this 2U rack NAS offers a feast of storage features and plenty of expansion potential. It's good value, despite not arriving with disks. **Diskless, £1,366 exc VAT; broadbandbuyer.co.uk**

REVIEW: pcpro.link/alsynology

SECURITY

Sophos SG 115w

A security appliance that gets it right on almost every level. Easy deployment, a huge range of features and a tempting price make this the perfect choice for SMBs. **With 1yr FullGuard, £809 exc VAT; sophos.com**

REVIEW: pcpro.link/alsophoss



Sophos Cloud

User-based policies and slick mobile support make this a top-class cloud solution. Performance is impressive, too. It's not the cheapest option, but it's a pleasure to use. **10 users, £510/yr exc VAT; sophos.com**

REVIEW: pcpro.link/alscloud

BUSINESS PRINTERS

Epson WorkForce Pro WF-5620DWF

Shatters the myth that inkjets are only for low-demand use, delivering fast output speeds, low running costs and tons of features.

It prints at 20 pages per minute, and quality is perfectly acceptable – it can even print glossy photos. **£187 exc VAT; printerland.co.uk**

REVIEW: pcpro.link/alwf5620



BACKUP

Barracuda Backup Server 290

A beautifully simple appliance that brings together on-site and cloud backup. There's block-level deduplication, extensive support for Windows systems and applications, integral Exchange MLB, and simple deployment and management. **£4,446 exc VAT; barracuda.com**

REVIEW: pcpro.link/alserver290



DataFort Critical Care

DataFort's managed backup service takes care of everything, even bringing up virtual clones of your systems should disaster strike. Per-server pricing makes it cost-effective too. **One server, £350/mth exc VAT; datafort.com**

REVIEW: pcpro.link/aldatafort

NETWORK MANAGEMENT

Paessler PRTG Network Monitor 15

A network-management solution that's ideal for businesses on a tight budget. Paessler's PRTG Network Monitor 15 supports a wide range of devices, which are included in the price, and licensing is based purely on sensor count, so there are no hidden costs. An excellent way to keep tabs on what's going on in your network.

500 sensors, 1yr, £1,017 exc VAT; paessler.com

REVIEW: pcpro.link/alprtgt15



SolarWinds Orion NPM 11.5

Offers excellent value for money, packing in a huge number of monitoring features as standard, including support for 802.11 wireless access points and virtual machines. **250 elements, £4,110 exc VAT; solarwinds.com**

REVIEW: pcpro.link/alnpm115

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Profile

BACKGROUND INFO ON INNOVATIVE BRITISH COMPANIES

MEEM

Kelly Sumner helped create some of the biggest titles in video-game history. Now he wants to make smartphone backup effortless

KEY FACTS

IN A NUTSHELL

MEEM is a startup company with a simple solution for smartphone backups: its charger cables include a block of flash memory that automatically backs up the phone's data when you're topping up the battery. It's run by former games executive, Kelly Sumner.

LOCATION London

FORMED 2013

STAFF 50
(worldwide)

WEBSITE
meemmemory.com

RIGHT The concept is very simple: a phone-charging cable that also backs up all of the data on the device

There are many reasons why people want to be a CEO of a startup, but a poor backhand isn't usually one of them. Yet after a career that spanned stints as the head of Commodore UK and running games companies that produced massive hits such as *Guitar Hero* and *Grand Theft Auto*, Kelly Sumner realised retirement wasn't for him.

"I got bored," said Sumner, explaining why he's back at the helm of a new company, having twice come out of retirement – the first when he was still only in his early forties. "I was at home trying to play tennis and I wasn't getting any better."

Instead of working on his serve, Sumner ploughed his energy into mentoring startups. This is how he met an entrepreneur with an idea he believed was so brilliant that he decided to help out and run the company himself. Now, as the unpaid CEO of MEEM – a phone-charging cable that also backs up all of the data on the device – he believes he's sitting on another billion-pound opportunity.

Game on

Kelly Sumner certainly doesn't need the hassle of running a startup. He joined Commodore when he was 16 as a trainee electronics engineer and worked his way up to CEO in 13 rapid years. The Amiga-maker famously imploded in the mid-1990s, but Sumner moved on to enjoy even greater success, becoming the CEO of US

game publisher GameTek, which was eventually sold to Take-Two Interactive.

While Sumner was at Take-Two, he helped put together a last-minute deal to acquire British games publisher BMG Interactive, which at that time had a middling games franchise called *Grand Theft Auto* on its books. *GTA* went on to become an enormous worldwide hit and Sumner became Take-Two's CEO, before retiring early and selling his shares in the company in 2003.

Sumner soon tired of tennis lessons and returned to the games industry as non-executive director of RedOctane, where his team came up with the idea for another seminal gaming hit: *Guitar Hero*. He took over as CEO in early 2006, but, just months into his tenure, RedOctane was sold to Activision and Sumner was looking for a new challenge.

After spending some time living in New York, Sumner returned to the UK, but decided he couldn't face another job in the games industry. "I thought, I've played in the Premier League a couple of times, I don't really want to play Sunday League now, and I don't want the corporate bull****, for want of a better word," he said. Without any financial need to ever work again, Sumner decided to start investing in small companies and mentoring entrepreneurs, effectively becoming a "Dragon"



FAR RIGHT The cable offers a foolproof alternative for those who don't want to use cloud technology

RIGHT Kelly Sumner has also set his sights on the tablet and laptop markets



without the camera crew. “No-one’s paid me a wage, no-one’s paid me any consultancy, I’ve done everything for free because – you know something – I was very lucky and successful, and I think I’ve got a responsibility to help other people.”

■ A backup plan

It was while scouring for his next investment that Sumner ended up chatting with an inventor called Anil Goel for hours. Goel had come up with a stupidly simple device that would stop people losing their photos, videos and messages every time they lost their phone. Called MEEM, the device is essentially a block of flash memory built into a smartphone-charging cable, which backs up the contents of the device every time it’s plugged in to charge. There’s no chance of forgetting backups and no need to set up cloud services: all you have to do is enter a PIN when it’s first set up. It’s perhaps the simplest backup system ever created.

Sumner immediately thought it was brilliant, but Goel was struggling to get the product off the ground. “He is a really lovely guy, but he looks like an Indian rock star,” said Sumner. “And with the greatest respect, rock stars don’t often garner the idea that you’re going to give them lots of money to produce a product, and he’d never produced

one before. He needed someone to help him, he really did.”

Sumner wasn’t only motivated by helping Goel stop sleeping on other people’s floors – he also wanted to find out if his own achievements were something of a fluke. “From an ego perspective, I have been very successful, but maybe I’ve been really lucky. *Grand Theft Auto* and *Take-Two*? Maybe it was really luck – I don’t think it was. Maybe *Guitar Hero* was really luck? I don’t think it was. How many times can someone be lucky? This will be the third time, and in a different industry so, from a personal perspective, I’ve something to prove to myself.”

■ Too good to be true?

Sumner said he came out of his first meeting with Anil Goel convinced that “if it did what it said it was going to do, I thought it was amazing”. He then spent the next few weeks touring all the major telcos in Europe and the US to do his “due diligence” and find out if there was anything else like MEEM on the market. “There wasn’t, so I was in,” he said.

There are, of course, now cloud backup services built into Android and iOS, but Sumner says his research shows people simply don’t use them. “Even if you sit in front of the platform holders, they will tell you they [consumers] don’t use it,” he said. “People really don’t trust the cloud.

‘Where is my stuff? Who’s looking at my pictures?’ They’re not using it because they don’t trust it, and they don’t know what it means.”

In fact, Sumner says one of his biggest challenges has been to convince people that MEEM can actually make backup as foolproof as he claims. “When I went round the telcos, they were saying ‘it’s not possible’. So when we produced the first samples, we had them engraved with ‘it’s possible’ just to have a little dig.”

However, with a backup solution as simple as putting a flash memory chip inside a charging cable, there is a danger that others will rip off Goel’s idea. Sumner is not blind to the risk. “We have patents and they’re very strong patents,” he said. “We took the best part of seven years to get them approved in North America and Europe. If you are charging via a cable and backing up at the same time, you’ve broken our patent. It’s very broad.”

The need for an app to handle the backup process gives the company another level of protection. “I don’t believe either Google or Apple would allow people to infringe our patents or deliver apps that would infringe our patents.”

■ Sharing the spoils

MEEM has been partly financed by crowdfunding – £700,000 of its £2.5 million funds have come from investors online. But MEEM didn’t use Kickstarter or Indiegogo to create pre-orders for its product. Using Crowdcube, MEEM gave investors an equity stake in the company, with around 6% of the firm now owned by small investors.

If MEEM hits its ambitious targets, the crowdfunders won’t just get a one-off product, but a genuine return on their investment. The firm aims to sell five million units next year, and 12 million the year after. But that will still leave 499 out of every 500 smartphone owners to chase. With MEEM cables costing from £50 for the 16GB model, there’s potential to become a billion-pound company.

The company’s not stopping at smartphones, though: a tablet version is in the works and Sumner plans to attack the laptop market soon. “Independent research said we would sell, in the first three years, between 23 and 27 million cables,” he said. “If we did that, I’d be a very happy man. If we sold more, I’d be even happier.” Certainly happier than he was batting balls back to his tennis coach anyway. **BARRY COLLINS**

What about you?

Do you work for a British technology company that could be profiled in PC Pro? If so, get in touch: profile@pcpro.co.uk

“There are now cloud backup services built into Android and iOS phones, but research shows that people don’t use them”



Viewpoints

PC Pro readers and experts give their views on the world of technology

Enough with the cowboy couriers: send in the drones

Online retailers live or die by logistics, but traditional modes of shipping are holding us back



Darien Graham-Smith is PC Pro's deputy editor; when it comes to his column, next-day delivery cannot be guaranteed.

This month my wife and I have been counting our blessings that we live in the age of online shopping. Our new baby girl arrived at the end of September, and of course our regular household routine has been shredded. The traditional advice has long been to stock up

in advance on frozen foods and essential household items, on the assumption that you won't be getting out to the supermarket during the weeks following the birth. Happily, when a next-day delivery of groceries and baby supplies is never more than a few clicks away, you can take a more ad hoc approach to these things. Install the requisite smartphone app and you can feed the infant with one hand and order the next load of milk and nappies with the other.

I've been a fan of online shopping since its earliest days. Back when Amazon was still an online bookshop, I was working at a manufacturing company located on a featureless stretch of road out towards Heathrow airport. There were no shops nearby to speak of, and heading into town after work was a significant expedition.

But it didn't matter. Thanks to Amazon, I could sit at my desk and browse a growing catalogue of products, and whatever I selected would almost invariably be waiting for me in the postroom the next morning. That last part was key: if Amazon had merely followed the shopping-catalogue standard of 28-day delivery, I'd never have bothered with it, and I certainly wouldn't have gone about evangelising the wonders of online shopping to my friends.

Now we're all accustomed to the convenience of online retail, providers no longer need to make such an effort. Next-day delivery from Amazon has become a premium service, and the pressure to constantly drive down costs means some seemingly respectable online stores are entrusting their deliveries to bargain-basement couriers, with predictably disastrous results. I'm sure we've all had the frustrating experience of wasting an entire day waiting in for an important package, only to be told that "you weren't home" when the courier allegedly called.

It's a baffling situation, because delivery is the one area where online shops absolutely cannot compete with the immediacy of the high street. The Amazon of two decades ago was smart enough to realise that fast and

“The pressure to drive down costs means online stores are entrusting their deliveries to bargain-basement couriers”

reliable delivery was a non-negotiable part of the proposition; entrusting your logistics to cowboy couriers turns what should be an easy and enjoyable transaction into days of disappointment and frustration, which can only drive away repeat custom.

Taking the long view, it's an issue of declining importance. I fully expect to see the day when consumer goods come down the line digitally, as recipes to be fed into our 3D printers – but that's not a solution for the here and now. We're decades from the point where a domestic machine can assemble a working loudspeaker or a comfortable pair of running shoes. And there are plenty of goods that won't be so amenable to the replicator approach, from fine wines to vintage cars.

So for now, and for years to come, we need to sort out the delivery situation. Because it's not just about how we get our books and

T-shirts. In my household, next-day grocery deliveries have been a tremendous help during our daughter's first months in the world; on a larger scale, such provisions could affect whole sections of society. As the commercial amenities on one's doorstep become less relevant, individuals and young families will find it easier to live further out from city centres. They'll be able to enjoy more spacious and affordable properties, and in turn ease the inner-city pressure that drives urban house prices sky high. Entire modes of life are up for grabs, and it's tremendously exciting.

But all of that rests on logistics. We can't be receiving bogus email alerts in the middle of the afternoon claiming that our doorbell isn't working and inviting us to drive up to Borehamwood to collect our milk and toilet rolls. We need a 21st-century delivery system, one that's capable of scaling up to handle unprecedented quantities of stuff being dispatched up and down the country every day. That can't just mean investing in exponentially more vans and drivers: the capacity of our roads is a finite resource.

We need a more ambitious and creative approach, of the sort that perhaps wouldn't emanate from a traditional courier company.

As it happens, you may recall that in 2013 Amazon announced the idea of having goods delivered to customers by aerial drone. At the time we all had a good laugh and congratulated the company for grabbing headlines with such an entertaining notion. But this summer it confirmed that trials of Amazon Air were underway:

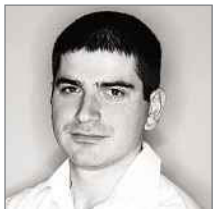
check the Amazon Jobs website now and you'll see 19 openings for full-time researchers and developers to work on the project. The company is taking the idea perfectly seriously, because it realises that for online retail to take its next step forward, something very much like this has to happen. No other approach offers the combination of speed and scalability that next-generation shoppers are going to demand.

You may have mixed feelings about Amazon: its tax arrangements have been frowned over in these pages before, as have reports of the way it treats its employees. But if I had to credit one company with getting the entire online retail industry off the ground, I'd point to Amazon. I'm willing to bet it can repeat the feat in a rather more literal sense.

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That encrypted headline makes as much sense as the government's new Investigatory Powers Bill



Barry Collins is a former editor of PC Pro. He can't do a cryptic crossword, let alone unencrypt an email.

It turns out that I'm a bit of a terrorist. Unbeknown to me, I've been yabbering away on WhatsApp without the first clue that the messages I've been sending have been jibberish by end-to-end encryption. Me, practically everyone under the age of 25 and the chaps from ISIS –

all chattering away without allowing anyone at MI5 to eavesdrop on our conversations.

Theresa May's none too happy about this, obviously. If my fellow Lewes FC directors are going to send WhatsApp messages about a striker we're planning to sign, she wants MI5 to know about the non-league Pelé first. If they manage to pick up any chatter about plots to blow up Tower Bridge in the meantime, all the better.

So the government has tabled the Investigatory Powers Bill, a sweeping piece of legislation that gives the government all sorts of powers to prod into "private" communications, not least the right to demand encryption keys.

In fact, according to the draft of the bill, the government already has this capability, as part of the Regulation of Investigatory Powers Act 2000. "Ripa requires CSPs [communications service providers] to provide communications data when served with a notice... and to maintain permanent interception capabilities, including maintaining the ability to remove any encryption applied by the CSP to whom the notice relates." The bill will bung together this existing right with other new measures, such as an obligation on ISPs to keep records of which websites we visit, to create "a single, comprehensive piece of legislation".

“If the government forced tech companies to drop end-to-end encryption, it would make little or no difference to criminals”

Alas, there's a sticking point. WhatsApp doesn't have the encryption keys (at least, not when the messages are sent between Android devices). Neither does Apple when you send texts via iMessage. This is end-to-end encryption: the keys are stored on the devices, not companies' servers. WhatsApp and Apple, let alone the mobile networks that transmit the data, couldn't unscramble your message if they wanted to. Even if the boys from MI5 got very sweaty indeed.

This is what prompted the prime minister earlier this year to float the idea of banning encryption – an idea that was shot down faster than a Ukrainian jet buzzing the Kremlin. Indeed, the Investigatory Powers Bill makes no mention of banning encryption – only the troublesome clause about forcing providers to hand over the keys remains.

What can the government do if WhatsApp (now owned by Facebook) or Apple can't give them the unencrypted data they require? Well, not a lot. Apple introduced end-to-end encryption following the Snowden revelations and has insisted it cannot and will not weaken its encryption at any government's behest. "We have never worked with any government agency from any country to create a backdoor in any of our products or services," Tim Cook wrote in a public letter to Apple's customers. "We have also never allowed access to our servers. And we never will."

The government could perhaps force Apple and WhatsApp to stick to server-side encryption, whereby companies hold the keys and the power to unencrypt data demanded by warrant. Indeed, WhatsApp does this for messages that aren't sent directly between two Android handsets, since it's still in the process of rolling out its end-to-end encryption technology.

As the well-respected Heise security team pointed out when it probed WhatsApp's security earlier this year, "we do not know if E2E encryption is actually used in all cases where this is possible, or if it is switched off when certain criteria, such as requests from intelligence services or when the device is in use in a certain country, are met." The technical capability exists for WhatsApp to switch off end-to-end encryption – and it's invisible to the user (unless you use software to inspect every packet of data).

Yet, even in the unlikely scenario that the government forced major tech companies to drop end-to-end encryption, it would make little or no difference to organised criminals. There are plenty of ways for terrorists to encrypt their communications without relying on a CSP. As AAISP's Adrian Kennard pointed out on his brilliant blog (revk.uk), PGP offers end-to-end email encryption, and anyone with the technical chops can set up a VoIP server to handle encrypted calls. Kennard even produced a short video showing how you need nothing more than a pen and pad for "unbreakable end-to-end encryption" (see pcpro.link/256kennard). By definition, terrorists and paedophiles

don't stop doing something because it's illegal. It's tempting to blame technical incompetence for the Investigatory Powers Bill, but, as IT journalist Rupert Goodwins said on Twitter, "I suspect that, like the reality of recreational drug use, the government understands, but dare not admit the understanding." Whisper it, but Rupert's probably right.

barry@mediabc.co.uk

Being Big Brother is like watching paint dry

We know being watched changes behaviour, but so does having CCTV at your disposal



Briefing and Futures editor Nicole Kobie was pleased to see Painter No 2 flick through a copy of PC Pro.

In *Nineteen Eighty-Four*, George Orwell describes what it's like to be watched all the time – "nothing was your own except the few cubic centimetres inside your skull" – but how does it feel to be one of the watchers?

When a camera is pointed at us, we act differently from

normal – the observer's paradox. Unless you're the sort that loves attention, most people become wary or nervous. But we also change when we're the ones peering through the lens.

I found this out for myself while testing a smart security camera, the Netatmo Welcome. Point it at a room and the facial recognition will attempt to recognise your mug, the idea being that it only sends notifications when an unknown visitor is spotted in your house.

That's how I ended up abusing a coffee shop's Wi-Fi to watch the most boring live stream of my life: paint drying in my own flat. The decorators were in that day, so I slipped out to work at a local café. The pair of painters triggered the camera – a nice trial to see if it really worked – but it soon became clear that it was me who was being tested.

A few hours in, a notification popped up on my phone with a video clip that showed Painter No 1 idly rifling through Post-it notes on my desk and – with bemusement in his voice – reading out my to-do list, which was clearly very different from his own. Eventually, his counterpart told him to get back to work, and he did.

I was immediately furious and felt violated. What an invasion of my privacy! Annoyed and worried, I spent the next few hours logging into the site anxiously to check on the painters via my smart camera, making sure they behaved themselves. Lord knows how much time I wasted that day – I was saved a little from my own curiosity by dodgy Wi-Fi – but it was captivating to watch someone go about their business in my flat.

Here's what I saw: they painted. For hours. And they did a fabulous job, cleaned up perfectly and left like the professionals they were. It wasn't my privacy being invaded, it was theirs – by me.

When we see camera footage, we expect to see something. It's surely a consequence of Hollywood: when the director's camera gazes at a door, we know a character is about to walk through it. Watch a pair of painters on video and you expect them to do something other than paint. This being real life, they don't. At least, not often.

It's equally hard not to apply film drama to CCTV camera footage. When I looked at my kitchen on the night-vision mode from my bedroom one night, I felt like I was watching a horror film, the grainy black and white straight out of *Paranormal Activity*. Creeped out, I kept expecting someone to sneak into the room or for objects to move of their own accord. Of course, nothing of the sort happened, but that didn't stop me from tossing and turning for a few hours before drifting off into scary dreams.

If we use the Internet of Things to monitor the world around us, how will it affect our minds? What's the psychological effect of watching and measuring everything? Becoming a watcher changes how we think. Big Brother was bad news for Winston Smith, but it wasn't healthy for the minds of the camera operators, either.

Such self-surveillance also affects how we deal with the people around us. If you're always checking your smart camera or home sensors to see when your family get home, it suggests you don't trust them to give you an honest answer.

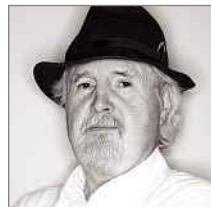
Of course, there's a benefit to such a video feed: it would probably catch theft or other crimes. But who am I to begrudge a painter curiosity about the space he's working in? If I wanted those papers left alone, I should have slid them into a drawer before letting strangers into my home.

I've unplugged the camera. I'd rather have my stuff stolen than lose trust in friends or strangers, and I'd rather have my papers flipped through without my knowledge than feel anxious and paranoid about the possibility. I'd rather not know than become Big Brother in my own home.

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How fresh thinking dealt new life into an old game

If programming is a religion then hallelujah – it's time to share a true story of conversion



Column for Column in PCPro if editor_approval == True]. (He also edits the Real World Computing section.)

One of the more frequent topics of this column has been my interest in programming, both as an important economic activity and, for me, a pleasing pastime: I refuse to call it a "hobby". My last such column was about Scratch, an innovative Lego-like visual programming language for teaching children (and adults) invented at MIT. I confessed how quickly I'd become hooked by Scratch's blocky metaphor, despite a few major limitations. At the end I mentioned that some Scratchers in Berkeley had extended the language to remove these limitations, and called it Snap. It was more or less inevitable that a wet weekend would arrive when I'd take a deeper, non-cursory look at Snap, and when it did I was re-hooked several times over.

Snap looks much like Scratch, similar enough to execute most Scratch programs with little or no alteration, but it adds several

“Programming languages, like religions, can attract fanatical adherents who become impervious to criticism”

features that make it more grown up. In place of Scratch's table-like arrays, it has dynamic lists as first-class, named objects; it has local variables, not merely globals like Scratch; and it supports "continuations" that enable you to pass one block as a parameter to another block, a feature from advanced functional languages such as Scheme and Haskell.

Given its similarity to Scratch, learning Snap was, er, a snap and within a day I was looking for serious programs to convert. I settled on some I'd written several years ago in Ruby, including a visual matrix calculator and a simulation of a simple ecosystem called "Critters". Both went easily into Snap and

worked well, Critters ending up as a single smallish block, thanks to the Scratch/Snap concept of "sprites" (animated screen objects) that took care of all the graphics with no coding on my part.

Anyhow, this conversion job made a deep impression on me. It may not have escaped you that programming languages have something in common with religions, in that they attract fanatical adherents who become impervious to criticism. My casual flip from Scratch to Snap was a sort of apostasy and I'd enjoyed it, so I began sifting through my other Ruby projects. In the process, I discovered an abandoned poker program in Python. I'd flirted with Python back in 2002 but quickly abandoned it in favour of Ruby, on almost entirely aesthetic grounds. In those days I was a fanatical object-orientation nut and I hated Python's OOP syntax, which involves prefixing just about everything with "self".

I've become more ecumenical since, and that weekend of Snap coding had revived my enthusiasm for Lisp-style list programming, so to my own surprise I decided to finish that poker program in Python rather than convert it. I downloaded a more recent version, WinPython 64-bit 3.4.3, and set to work. Instead of pursuing the pure OOP architecture I'd started with – card as a class, hand as a class, player as a class and so on – I rewrote the lower levels using Python's "tuples" instead. Each card is just a tuple (facevalue, suit), while a deck is a 52-piece list of tuples. Soon I'd rewritten the whole thing using only tuples and lists, and never mentioned a class until I reached player level. My code shrank to half its size, ran many times faster and, more importantly, it worked, which the original never really had. (Crucial to this success was Python's "list comprehension" construct, a fiendishly clever one-line trick for building lists by pattern matching.)

This taught me a serious lesson, one that may help you too. Rigidly adhering to a single methodology can be counterproductive: recognise which tools are right for each job and use them, regardless of dogma. Cards, decks and hands didn't need or deserve to be objects (no inheritance required), while players did as they have many attributes – a hand, a bankroll, a strategy, a personality. When

I wrote the program in strict OOP style I'd actually obscured its structure, in favour of a class hierarchy the language imposed on me.

Good programming is an art, one in which an eye for structure is even more important than a head for logic. Factoring, that is breaking down your code into smaller chunks in the best way, and choosing the right data structures, are far closer to musical composition than science. What a pity that, unlike mathematics which occasionally spawns a Hollywood movie, beauty in programming can only ever be recognised by a handful of fellow programmers.

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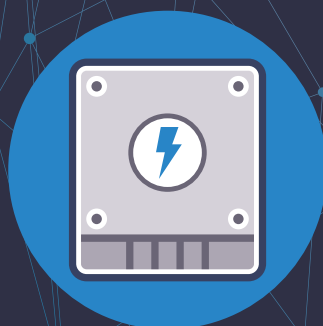


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Mark Lister

Experience engineer

■ What is experience engineering?

It's the meeting of design and technology. At Ness (ness-ses.com), we're a team of 30 designers outnumbered by 3,000 engineers, so rather than turn all the engineers into designers – which we want to do subtly – we have to think like engineers.

For the first time, the designers are thinking about user experience in terms of the features that enable it, and we're training engineers to think in terms of experience.

■ What part did your qualifications play in helping you get your job?

I've actually got a degree in physics, so maybe that's not so relevant, aside from the logical approach to problem-solving. There are a couple of obvious routes into the field. One is taken by people from agencies who think they would like to work on something meaty. They realise that the enterprise is less impressed by just design for design's sake, and is far more interested in solutions to recurring problems.

People's artistic leanings are applied to a user experience (UX) logic of information flow where someone says "I'll let you put a lovely design on it, but break the problem apart first". They drift into UX because it's a way you can quickly map out a problem to find its solution.

The other route is taken by developers – people who have knocked up a few websites, for instance – who like tinkering around with the world of tech, but want their work to be seen by more people. They might lack visual design skills, but that's okay because the shortage we have is of user experience strategists, designers and consultants.

In an interview, I'm looking for people with life experience and a confident way of speaking, because they're going to be talking to a lot of people. The job isn't about spending lots of time at your screen: you spend very little time at your desk and most of the time interviewing people, talking to people, understanding their pain points with software, and understanding what they would like it to do.

I want someone who can step into a room and make everyone in it part of the debate – someone who sketches out ideas and puts Post-it notes on a whiteboard, and has enough energy and enthusiasm to get people to contribute so that, at the end of a session, we have consensus from a team.

The best way to get into this is to have a hunger for improving software – and that's a very important skill. It's the one I'm looking for the most. There are plenty of people who can handle the execution of what we're doing – turning wireframes into software – but I need someone who can create wireframes from the page, who has the initiative to sketch them out, to gather requirements and explain them to clients. To do that, you need someone who can jump up on their feet and make ten people talk, because that's what they're paying us to do. I always say there's a bit of showbiz in releasing that energy.

■ What's the career path?

The entry point is a researcher with curiosity, hunger and digital savviness, who will do a lot of competitor research, working out why certain sites are working better than others and how they're generating revenue.



£25k
Approximate
starting salary

96
Permanent jobs
(itjobswatch.co.uk)

£48k
Average
earnings

After that, you'll start doing wireframing, where the intelligence has been gathered by one of the senior researchers and you're helping them – so you might not necessarily be exposed to the client.

As you work up the chain to become more valuable to the company, you're getting closer and closer to the client and the person who commissioned the work. That's the point at which you have to stand up, having examined the problem, and have some interesting and challenging questions that will make the client think.

The next step is to become a UX practitioner, then a UX strategist, before you become a head of team.

■ What advice do you have for someone who wants to work in the industry?

The field of user experience goes back 30 or 40 years. As soon as you start reading about how Silicon Valley companies got going – such as Facebook, which is technology but with an incredible focus on design and data – you'll discover Lean UX and prototyping. You'll easily find people blogging, TED talks and links to the sites you need to understand the ecosystem quickly. Reading about the Silicon Valley startups is the best place to start. Overall, it's important that you read up on, and understand, what the title UX designer really means before you start submitting applications on a job site. ●

Where to start

- "The beauty of data visualisation", TED talk by David McCandless: pcpro.link/256careers
- "How giant websites design for you (and a billion others, too)", TED talk by Margaret Gould Stewart: pcpro.link/256careers2
- What does a UX designer actually do? pcpro.link/256careers3



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Readers' comments

Your views and feedback from email and the web

Office 2016 nobbled

For those of us who don't want to hunt through the various ribbons in Microsoft Office to find a particular button, the Quick Access toolbar has always been a very useful alternative. Or at least it was as far as Office 2013.

Now, in Office 2016, it's been nobbled by increasing the width of the icons and fails to give us an option to switch back to the previous size again.

It's said that a small minority of users customise the Office interface. However, those who spend their lives analysing how users behave have missed the obvious fact that the user who adds icons to the Quick Access toolbar usually adds as many as they can fit in across the size of window they use. In Office 2013, my icons – which included some to trigger macros – would have easily fit across the whole of my 23in screen. But, for two equal-sized Word documents, I did have to place the most useful ones to the left and lose a few behind the ">>" button. In Word 2016, only just over half of those visible on a half-screen document in Word 2013 are now visible, radically impacting my productivity when commenting on other people's work.

Members of the online community who have written about this want to revert to Office 2013, because there are no enhancements in the 2016 version that outweigh this crass piece of design. For the time being, I am hoping that Microsoft will remember that most real work is done on laptops or desktops, and fix this "tablet-friendly" feature in the very near future – either by providing the option to revert to the previous size or, better still, by offering a range of sizes that go lower than the previous size.

Peter Thomas

Flash

I followed Davey Winder's advice (see issue 254, p118) and disabled Adobe Flash in Chrome, only to find that BBC iPlayer didn't work and I wasn't even able to play audio on the BBC Three site. It seems that the BBC does not share Mr Winder's reservations about Flash security.

Alan McMinn

Star letter

Thank you for Nicole Kobie's excellent article (see issue 254, p25) on the wonders of the netbook.

I am on my second netbook. The first was an Asus Eee PC, which was really a joy to use. My current netbook is an HP Mini, which has travelled to and from Australia, where I used it to Skype home.

As a workhorse (or should that be a Shetland pony?), I have nothing but praise. It's so handy,

takes up little room, runs Windows 7 and has good battery life. As a writer, to be able to have my HP Mini with me means I can write anywhere, any time. I have no need for all the "fancy" additions to many laptops and smartphones.

I use a desktop in my study, but on the road my netbook rules, OK! **David Clowes**



This month's star letter wins a set of Creative T15 wireless speakers, worth £60. To find out how they could give your music a boost, visit uk.creative.com



ABOVE BBC iPlayer still relies on Adobe Flash in Chrome, despite our concerns

Davey Winder replies: The fact that the BBC, and many other providers, do not share my reservations is a big part of the problem – especially when there are plenty of more secure alternatives available. Ultimately, though, it's your choice as to whether you think the security risk is worth taking in exchange for the content provided. Just don't say I didn't warn you.

The A-List and Awards

I follow the A-List with interest and put faith in the recommendations, to the extent that I recently purchased a Netgear Nighthawk router and am very pleased with it.

Then I looked at the Excellence Awards in the latest issue and the top rating is DrayTek. Why the sudden change? Netgear had been at the top for some time, only for it

to be inexplicably demoted now.

I am also confused as to how Giffgaff can get a rating so much superior to O2, the network on which it piggybacks. I can understand customer service being much better, but how can reliability and speed

be so much better? Surely you can't expect us to believe that O2 prioritises Giffgaff's traffic above its own?

It seems very odd to me – is this a case of pundits glamorising their own choices? **Patrick Davies**

Tim Danton replies: An interesting question – the key thing about the Excellence Awards is that all of the company ratings are based on reader feedback. So, if 100 out of 100 readers who have bought DrayTek's routers rate their reliability and speed as excellent, then they'll gain higher results than a rival where only 90 out of 100 readers rate them as excellent. But it's not about a specific product, it's across all the company's products (and includes customer service).

This means our Awards reflect how satisfied people are with the speed and quality of a product or service, which means that other factors – such as how much they're paying for the service – can come into play. That's probably why Giffgaff scored more highly for speed and reliability than O2 (although not by huge amounts), but really pulled away for value for money.

Taming Windows restarts

As a regular reader, I sometimes find myself in disagreement with the views expressed in the Readers' comments. I have no problem with this as everyone has a right to their view.

I was, however, surprised to read your star letter in issue 254. I upgrade my programs when I decide to and restart when it is convenient for me. I find Windows updates annoying, but have never been forced to restart. I have Windows Upgrade set to "always notify", and I let the upgrades install in the background. When they are finished, I always choose the option to restart later. This means I can finish my work and restart when it suits me. If I forget, it will install when I shut down. **Bill Cooke**

BELOW Why didn't Netgear's router win the PC Pro Excellence Awards when it's in the A-List?



Windows 10

Your review of Windows 10 (see issue 251, p60) was interesting, but was rather lenient on one or two “features”. In particular, the “improved Start menu”, which, in fact, is a dog’s breakfast. The “All apps” list is alphabetic, but it doesn’t make any sorting or organising easy.

There are two logical ways to organise applications. One is alphabetically, as with Windows Phone 8.1, and the other is to group programs into folders by function. Windows 10 turns this into a mush.

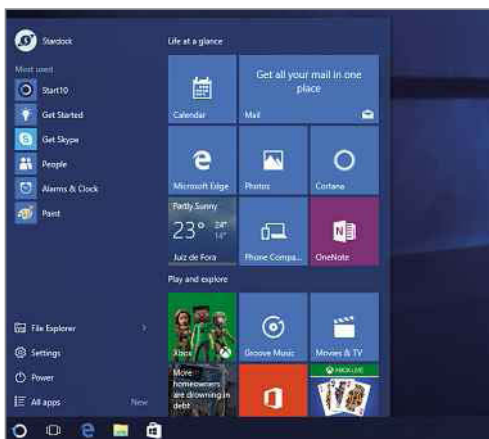
Programs can each install their own folders, complete with whatever links they choose to include. Moving the useful links out of the folders and into the alphabetical list and removing the useless folders is difficult. Creating and moving links into

Microsoft adds links to its Modern UI-style apps to the alphabetical list, and they can’t be moved or hidden

custom folders by category is equally complicated. You need to open a folder and right-click on a program in it to get to where the link actually lives.

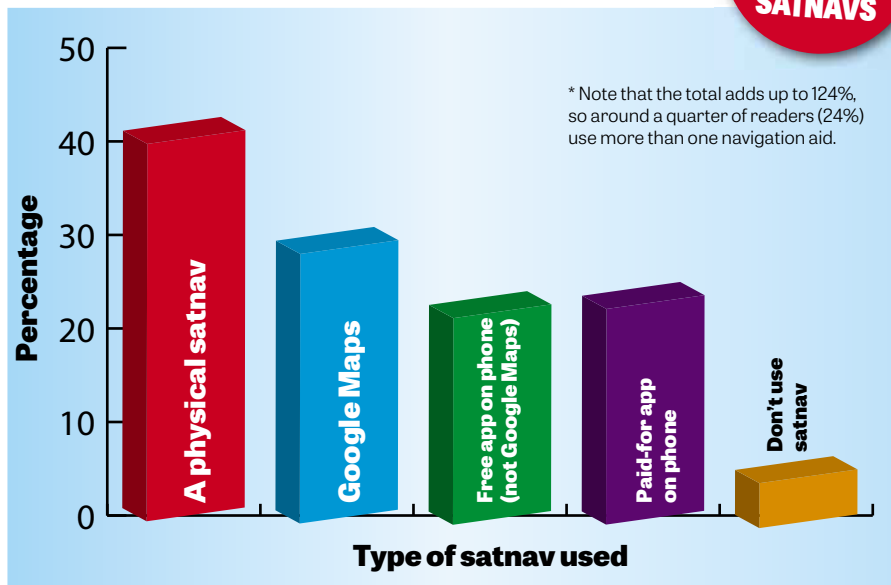
Microsoft also adds links to its Modern UI-style apps to the alphabetical list, and they can’t be moved at all, let alone be hidden away. Furthermore, when Windows or a particular program updates, it’s back to square one

So you end up with a list of links to programs, or Modern apps, and folders containing links to other programs. If you can’t always remember what a particular program is called, you can’t have it grouped in, say, a folder called “Media” without a load of complicated fiddling around. **Terry Bernstein**



Readers' poll

We asked you: what kind of satnav do you use?



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It’s fair to say we were quite surprised by the responses to our question, with almost half of *PC Pro* and *Alphr* readers using a physical satnav device rather than software on their mobile phone. That could be because so many cars have navigation features built into the dashboard, either by default or as a media deck upgrade, but, either way, it’s good news for the big-name satnav houses, which frequently provide the software that underpins them. Just one in 20 didn’t use satnav at all, having either great map-reading skills, or an intuitive sense of direction.

I put the street name ‘New Road’ into Google Maps and it took me to a road that was still under construction Colin T

We ended up on the wrong side of a river near Hereford. We had to retrace our steps and found a sign saying ‘Don’t use satnavs’ Ian Greet

We were in Italy and the satnav gave us a route, but it was very narrow. There was barely two inches either side of the car! Amit Nicholas

I was delivering a toy plane I had sold and the satnav made me drive in big circles. It wiped out my profit and cost me £30 extra in petrol Terry Lewis

Never had any problems whatsoever and, if the satnav is out of date, I use my eyes Warren Gill

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Drive **FASTER** **THE BEST SATNAVS** **FOR 2016**

Which satnav app will get you briskly past the traffic jams, and is there still a case for dedicated satnav hardware? **Dave Stevenson** dons his driving gloves to find out



These are challenging times for satnav makers. Smartphones offer more processing power and higher-quality screens than ever, as well as persistent internet connections for map updates and traffic information. The writing is on the wall for standalone satnav units: Garmin and TomTom have branched out into fitness watches, while specialist Mio now produces GPS-enabled dashboard cameras, as well as navigation units.


There are plenty of options for smartphone-toting road warriors, from high-end options such as TomTom's £30 app to standard-issue options such as

Google or Apple Maps. Other freebies, such as Waze's crowdsourced navigation app, are also strong contenders for dashboard duty. Here, we've exhaustively tested each, rating for ease of use, performance, and how each app performed when it came to getting us out of traffic and onto free-flowing roads.

Independent GPS hardware is still out there, though, and the competition from smartphones means manufacturers have had to up their games to match. We've got two high-end devices to see if they can tempt *PC Pro*'s hardened smartphone users away from their app stores and towards more traditional satellite navigation.

■ How we test

We loaded a car with a test iPhone and our two hardware contestants and set off across south-east England. Over several hundred miles of motoring, we tested each on major and minor roads, assessing clarity, usability and ability to avoid traffic.

We also timed how long it took to deliver a plan for a long drive, and each satnav had its point-of-interest database probed – finding a petrol station with a few screen presses can be a lifesaver. Smartphone apps have a major advantage here, so we looked at how easy it was to update standalone hardware with up-to-date maps and POIs. 



The HARDWARE

TomTom Go 6100

Great features, giant screen, worldwide maps and free traffic reporting, but the price only suits daily drivers

SCORE ★★★★★

PRICE £217 (£260 inc VAT) from halfords.com

The most expensive app or device on test by a factor of two, the TomTom Go 6100 needs to offer every feature under the sun to justify a price tag nearing £300. The Go 6100 has a decent stab: it's the only device or app here to come with worldwide street maps with free updates, plus free traffic monitoring and speed camera updates.

The latter two are delivered via GPRS – the Go 6100 has an integrated SIM card with a “lifetime’s” supply of free data and, usefully, free global roaming, so you won’t find traffic dark spots if you leave the UK. Unlike the Garmin, there’s no Bluetooth, so no updates via smartphone and no hands-free capabilities. The use of previous-generation internet means updates occasionally take a few seconds to come through after starting up the device, but we didn’t notice any lag in use, and 2G internet reaches areas of the UK 3G doesn’t.

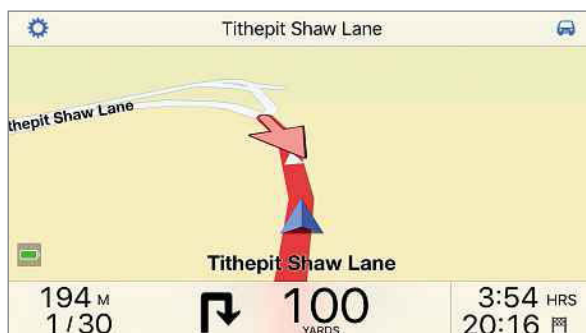
Installing new maps involves downloading them from TomTom’s website – from around 50MB for those heading to New Zealand and over 6GB for those needing all of Europe or North America. With 8GB of internal storage, it’s the quite humble the Go 6100 has all the space many drivers will ever need. For those who want two massive maps at once, there’s a microSD slot to save you having to rotate maps.

The capacitive touchscreen measures a generous 6in across and has a resolution of 800 x 480. As with the Garmin, that’s a little behind the curve set by smartphones, but it means icons, navigation and the map itself are all easily visible. The steep price also includes a superb dashboard mount that includes a charging connection for the device itself, so when you pop it off its mount you don’t need to worry about unplugging it. The mount is magnetic, meaning you don’t need to persuade it free and, despite

the Go 6100’s chunky 300g weight, the mount and the ball-and-socket arm stayed resolutely in place, no matter what kind of teeth-shaking roads we treated it to.

In use, the Go 6100 was excellent. The menu system is sophisticated and clean, with big, clear text that allows for instant comprehension and quick, confident navigation. Its onscreen keyboard is very responsive – the letter you’ve pressed pops up above the button on the keyboard to let you know you’ve hit the right one, allowing you to make quick changes to your route. As with the Garmin, the Go 6100 includes a hopeless voice navigation system. System commands – such as “Hello TomTom” to wake it up – work well, but the system misinterpreted almost every attempt to dictate a street name.

The Go 6100’s actual navigational chops are second to none. The map display is big, high-contrast, and the voice prompts are easy to understand. Its split screen for motorway junctions is superb, and the combination of top-quality voice prompts and the



ABOVE The Go’s touchscreen is a generous 6in and has a resolution of 800 x 480



“The system’s traffic alerts proved uncannily accurate, with traffic jams appearing with near-perfect precision”

clear map meant we drove with complete confidence. The system’s traffic alerts also proved uncannily accurate, with traffic jams appearing with near-perfect precision.

Routing was sensible, although unlike TomTom’s app, you don’t get the flexibility when declaring a preference for how you’d like to drive. You can avoid motorways, or opt for the shortest, fastest or most eco-friendly route, but can’t set a preferred maximum speed limit. Elsewhere, the device’s reporting

of speed limits was flawless, and you can opt to set an alert if you nudge over, although you can’t set a tolerance. Its integrated internet connection receives live updates of mobile and static speed cameras you’ve spotted with two prods of the screen – the modern-day equivalent of flashing your lights to warn oncoming traffic.

For those putting in truly galactic mileages, the TomTom Go 6100 is a luxurious companion. The huge screen beats all but the largest phones, and for seeing what needs to happen next, we’ve no complaints. The menu system makes sense and features such as free traffic and speed-camera updates make it easy to appreciate where the extra money has gone. It’s also the only device on test to offer free worldwide maps – Nokia’s Here is nowhere close for usability. Only a handful of drivers will get true value for money from the Go 6100, but it leaves nothing out.

Garmin Nuvi 2599LMT-D

A crystal-clear map view makes this a pleasure to use, while free traffic reporting works exceedingly well

SCORE ★★★★★

PRICE £117 (£140 inc VAT)
from johnlewis.com

The Nuvi 2599LMT-D has easily the ugliest colour scheme of any of our devices or apps on test. Even CoPilot's cluttered display can't hold a candle to Garmin's purple, jaundice-yellow and pastel-green display. The Nuvi's 5in display has a resolution of only 480 x 272, too, which makes it look decidedly old-school next to the high-DPI displays on smartphones.

That's where the aesthetic complaints end, because the Nuvi 2599LMT-D had the most instantly intelligible map display of any of the devices or apps here. The map itself is big, bold and clear, and the extra information – your speed, the name of the road you're on and your current ETA – is legible at the bottom of the screen. The next navigation point, as well as the name of the road you're turning on, appear at the top of the screen. Motorway driving is made easier by the presentation of a split screen showing you both the standard map view and a 3D lane-by-lane display showing where you need to move.

Driving with the 2599LMT-D was a breeze, and we never needed more than a quick glance to divine what was coming next. The map could occasionally become a tad busy – by default, the device is set to show nearby petrol stations, motorway service stations and restaurants, but it's a minor complaint, and you can turn these POIs off. We did, however, find the occasional rural road where Nuvi didn't know the speed limit. Overall, the TomTom edges ahead on the driving experience.

Voice prompts were delivered in time and with excellent clarity, with British road names arriving clearly. The Nuvi also offers voice navigation, but while it readily understood commands such as "Voice command" – used to prompt the system into action – street names were misheard with monotonous regularity. Siri it ain't.

The Nuvi proved very reliable when it came to traffic. Unlike other devices, which rely on

internet connections for updates, it uses an internal DAB radio to receive updates every minute. It proved exceptionally reliable, alerting us to jams, slowdowns and road closures to a very high degree of accuracy. It also picked up a road closure that others failed to detect. DAB traffic coverage is for the lifetime of the device and it's free. Navigating alternative routes is easy, with delays and alternatives presented in terms of how much time you'll save, allowing you to make simple decisions about what to do.

The lack of internet access wasn't a problem elsewhere, too. The Garmin's extensive POI list is provided in part by Foursquare, and a companion smartphone app for Android and iOS devices can be set to provide live speed-camera, parking and traffic data. The Nuvi's uncanny ability to spot jams via DAB, plus its already-impressive speed camera database, meant the £14.99 subscription cost to Smartphone Link's extra traffic and speed camera alerts isn't tempting – the device does a good enough job out of the box. You also get Live Parking, which allows you to see nearby car parks, complete with opening hours and costs.

ABOVE The Nuvi's 5in display only has a resolution of 480 x 272, which makes it look old-school

"It proved exceptionally reliable, alerting us to jams, slowdowns and road closures to a high degree of accuracy"

The Garmin pairs with a smartphone via Bluetooth, and its internal speaker and microphone can also be used as a standard hands-free kit. The main drawback is that using a smartphone to provide data means using your phone's 3G, Bluetooth and GPS capabilities, prompting plunging battery levels. The Nuvi's integrated battery will last two hours – the same as the TomTom GO 6100's – but a double car charger could be an idea for anyone wanting to use the accompanying app.

Unfortunately, you can't use the smartphone app to deliver map updates. Instead of being incremental, or live online, map updates are delivered to your desktop PC and then sideloaded to the Nuvi. A map update for the UK and Europe – the device's default configuration – weighed in at a monstrous 6.6GB and took well over an hour to deliver and install. Waze's on-demand, online approach has never looked so tempting.

We're huge fans of Garmin's map view – while ugly, it's undeniably clear. The big screen is a plus, despite its relatively low-tech specs, and the integrated, internet-free traffic updates were also excellent. A final plus is the dashboard mount – the ball-and-socket arrangement stayed resolutely in place no matter the road conditions.

At £140, it's relatively expensive – a smartphone with a decent-sized screen and, say, TomTom's app will offer stern competition – but for those without a smartphone, or wishing for navigation with a bigger screen, the Garmin delivers a terrific combination of performance, features and ease of use.



The APPS

TomTom

Crystal-clear guidance and traffic management make this the top choice for frequent drivers

SCORE ★★★★★

PRICE iOS: **£26.99**; Android: **free** for 50 miles per month, **£14.99** for 12 months, or **£34.99** for three years with traffic



TomTom's simple, powerful app shows no sign of slipping. Its appeal lies in its clarity. Its maps are cleverly zoomed in by default – enough to let you know what you're doing next, but not so much so that you don't have any context.

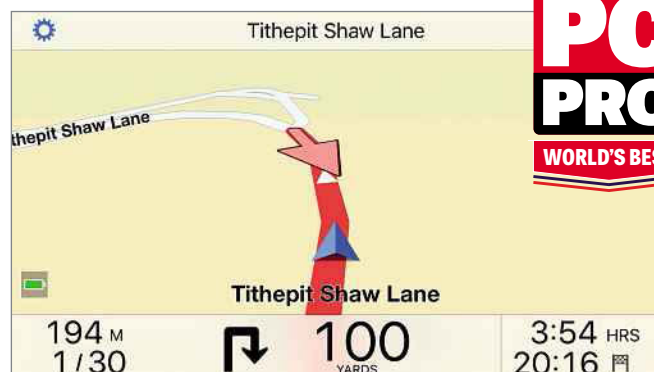
The essentials – namely your next turn, the total time remaining of your drive and your ETA – are all clearly displayed in large type. The app also shows which lane you should be in and which road signs to follow as you approach junctions. Speech

instructions are equally clear: the app recognises when turns follow each other in quick succession, and creates run-on sentences such as “take the second exit at the roundabout, then stay in the left lane”.

The price includes a speed camera database: during our tests we didn't spot any active speed cameras that TomTom didn't warn us about. The leaden-footed can also opt for the £1.49 per month (or £15.99 per year) speed camera in-app purchase, which adds mobile speed cameras and static units. Your speed and the speed limit you're currently in are also reported, and you can be alerted if you edge over.

Another add-on is the £17.99 per year, or £2.99 per month, TomTom Traffic. This far outshone rivals such as Google Maps and Waze: traffic jams were detected with spot-on accuracy.

TomTom's experience shows. You can change the default route type and its IQ Routes technology produces routes that take historical traffic data into account. Moreover, you can opt for more economical or shorter routes, with no motorways, limited speed limits or even “winding roads” – although, in our test, this meant



ABOVE The maps are zoomed in, but not so much that you lose context

TomTom simply directed us down endless cramped country lanes.

It's an expensive app, but for clarity, performance and ease of use – critical while at the wheel – nothing beats it. Frequent drivers won't regret splashing the cash.

TomTom meets Android

Android users get a slightly different TomTom experience. The company's legendary reliability and clarity of design is in evidence, but Android users also get 3D maps, as well as speed cameras and traffic. On Android, the app is free for the first 50 miles you drive per month. After that, you can spend either £14.99 for 12 months' service or £34.99 for three years. That's a substantially better deal than you get with iOS – the iPhone users in the PC Pro office wait with baited breath to see if TomTom makes the same move on the Apple App Store.

Apple Maps

Integration with Siri makes this simple navigation app appealing, but it wouldn't be our first choice

SCORE ★★★★★

PRICE Free



Apple's much-derided Maps app has turned a corner of late. For non-drivers, the addition of public-transport options has been a boon, and it's been a while since its fans in the PC Pro office have been led seriously astray.

Apple Maps proved very accurate when it came to detecting traffic, but was often a little conservative in its routing, shepherding us along slow, winding country lanes instead of suffering a few minutes' delay along the high street.

Unfortunately, almost everything else has been left out. You can't choose the kind of route (for example,

avoiding motorways) and, like Jeremy Clarkson, it's oblivious to speed cameras and speed limits. The map itself is readable, but no match for Waze, TomTom or Google Maps. The distance to your next turn is presented in large type at the top of the screen, along with an arrow showing what you'll need to do. It doesn't show which lane you need to be in, though, and other information, such as your ETA or journey time, is displayed in pointlessly small text.

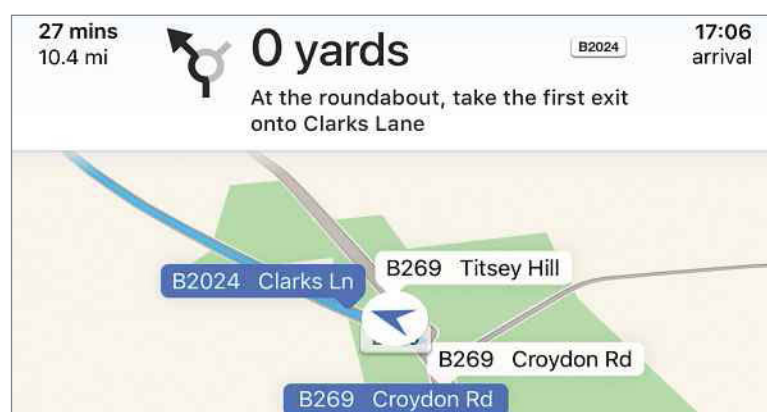
Siri, used to deliver voice prompts, proved harder to understand than Waze, and the way Siri omits the final syllable from numbers such as “20” or

BELOW The map is readable, but data such as the journey time is in tiny text

“30” hardly aided understanding when it came to road numbers.

It's a double-edged sword, though, because Apple Maps' integration with Siri is incredible. Being able to speak instructions to Siri while driving saves you having to reach for your phone, and Maps' system-level integration with its host iPhone means you don't have to load the app before you set off. You can trigger Siri at any point in your drive and begin navigating. That's handy if you know where you're going, but need to find the nearest petrol station.

Apple Maps is free and effective when it comes to A-B routing. It may suffice for occasional drivers, although Waze is also free and presents navigational instructions a little more clearly visually and much more clearly aurally. The ability to use instructions such as “Hey Siri, navigate to mum's house” is enormously redeeming, though. ➔



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Nokia Here Maps

Its global, free and offline maps are a killer feature, but Here lags behind in other areas

SCORE ★★★★★

PRICE Free



Nokia's free satnav app makes a poor first impression. Its instructions are spoken by a default American robotic voice that goes on about "traffic circles" instead of roundabouts. Meanwhile, the app pings politely but insistently at you if you break the speed limit by a single mile per hour. A few seconds in the settings menu fixed both: a 60MB download produced a far more intelligible, localised voice

Meanwhile, the speed limit alert was pleasingly flexible – you can set a tolerance of up to 20mph before it goes off, and you can have different tolerances for speeds between zero and 50mph, and 50mph-upwards (that said,

the traffic cops might not be so accommodating).

Uniquely, Nokia Here Maps lets you download worldwide offline maps once you've registered. The UK map weighs in at a little over 600MB, while larger countries such as France tip the scales at over 1GB. This has benefits for drivers heading to places

with little coverage, but the benefits are even bigger for those abroad. Offline maps mean no roaming data charges, and being able to navigate in, say, Namibia or Iceland without spending pounds per megabyte.

Alas, Here Maps has arguably the poorest map view of all. Its low-contrast blue and white colour scheme wasn't easy on the eye, and the 3D angle makes seeing beyond your immediate surroundings tricky. The arrow showing your next navigation occupies a generous fifth or so of the screen, though, allowing you to see what's next. It's not always hyper-accurate, occasionally showing the first exit on a roundabout as being 90 degrees to your entry onto the



ABOVE The map view is poor, with a low-contrast blue and white palette

roundabout when the first exit is straight ahead, but we learned to live with it. Adjustments for traffic are made on the fly and worked reliably in our tests.

The downsides are small – there's no speed camera database, but Here's POI list is well stocked. We also found a recurring bug where both the arrow showing your next navigation and the upcoming road name would stop updating. For instant comprehension, Nokia's Here Maps is roughly on a par with the decent Google Maps, but is still a touch behind the likes of Waze and TomTom. However, the global, free and offline maps make the device a great companion to take on holiday.

Waze

Its crowdsourcing features aside, Waze is an interesting, appealing and easy-to-use freebie

SCORE ★★★★★

PRICE Free



Google technically has two entrants in this roundup: it bought Waze in 2013 for \$1.1 billion. Unlike Google Maps, though, Waze's emphasis is firmly on driving, offering an amazing amount for free. Its layout, traffic reporting and voice instructions are all substantially better than Google or Apple Maps, but it lags slightly behind HERE Maps by not offering an offline mode.

Every Waze user contributes, either actively or passively, to Waze's traffic-monitoring system. If plenty of drivers slow down, a traffic jam will be declared and subsequent users routed elsewhere. There are shortcut buttons available from the main driving screen, from which you

can let users know about closed roads, accidents and other things that will affect their journey. Users can even enter fuel prices.

In reality, reaching for your phone while driving is distracting. Spotted a hazard? You'll need to choose whether the hazard is on the road or not, then choose from a further submenu of five different options. Realistically – and legally – you need to pull over to use it. Crowdsourcing is also inherently problematic in that you need a crowd: no problem in London, with plenty of "Wazers" providing hazard updates. Head to the sticks and the number of warnings falls off considerably – although so does traffic.



BELOW Waze's layout, reporting and instructions are better than Google or Apple's

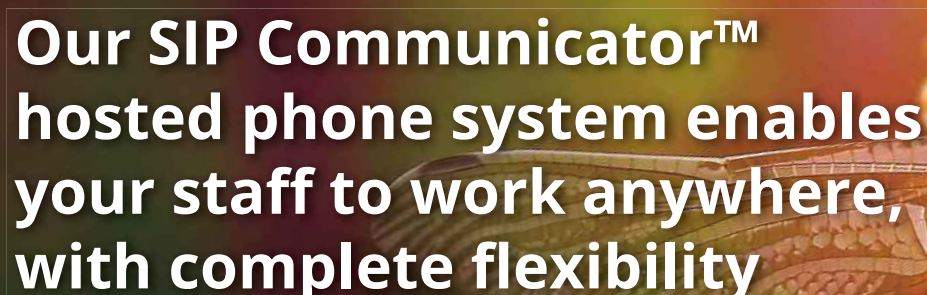
Waze's voice prompts were among the best, with its read-back of street names and road numbers easily comprehensible. Its chunky map display is clear, and it shows not only your next turn but also the one after that.

Waze's efforts to avoid traffic meant it often dispatched us down very small country lanes, where most will spend their time inching around blind corners rather than tolerating minor delays on bigger, faster roads. This also meant Waze sometimes produced longer routes. In one case, its first option for a drive was a 28-minute, 11.4-mile drive that could have been covered – according to its own alternative – in the same time

but in only 9.9 miles.

Waze is very impressive, whether you actively use its community features or not. Clear instructions and presentation, plus a decent level of traffic data, make it highly usable. It's our pick of the freebies, as long as you can live with its online-only nature.





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Google Maps

Clear maps and voice guidance, but the limited feature set reveals Maps isn't tailored to drives

SCORE ★★★★★

PRICE Free



Google Maps' turn-by-turn car navigation is still in beta, but it doesn't show. It's at least as fully fledged as Apple Maps, and benefits from a clearer map and more easily intelligible voice instructions.

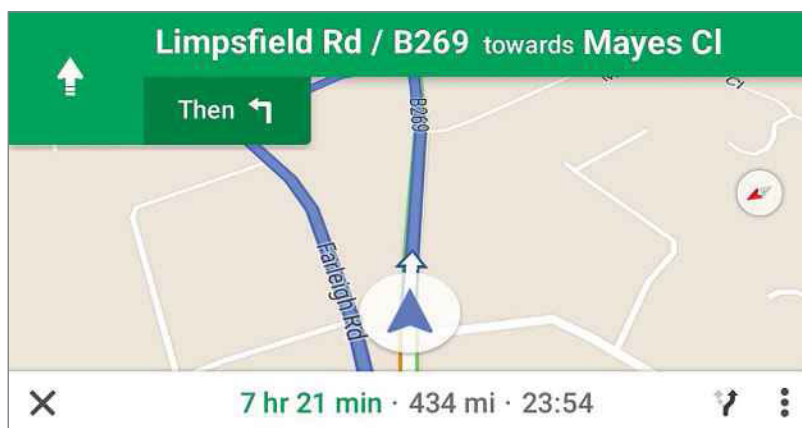
The blue, yellow and white map screens are easy to read and – most importantly – uncluttered, so it's easy to see at a glance what you have to do. Text instructions are kept minimal and to the point, and if there isn't a turn in the immediate future, the instruction "stay on the A24" or similar offers of reassurance that all's well.

Its main irritation is that, as soon as Google Maps declared that we had arrived at our destination,

it immediately dimmed the screen on our test iPhone. This happened irrespective of whether the phone was charging, and, as all drivers know, reaching your destination isn't always the end of a drive. It's sometimes useful for the

map display to continue to help find parking on a neighbouring street.

Google Maps also lacks the easy-access interface of Waze or TomTom. For example, big, easy-to-hit icons make way for a small text box. You can still dictate into it (via "OK Google" if you're using an Android device), but you can't, for instance, find a quick alternative route around traffic or a roadblock. Google's turn-by-turn display is accomplished and clear, but the app itself doesn't feel like it was purpose-built for drivers. That feeling intensifies when you notice the lack of a speedometer or speed limit alerts, likewise speed camera



ABOVE The blue, yellow and white screens are very easy to read

data. A further issue for some will be the lack of offline access. No internet connection means no navigation.

However, the benefits stack up elsewhere. Its traffic reporting is superbly accurate, detecting jams virtually to the metre, and its route planning proved ultra-reliable in our tests. Its exhaustive POI list is also a huge bonus.

We much prefer Google Maps' presentation to the other free apps here, with the honourable exception of Waze. The background feeling that Maps wasn't purpose-built for drivers sometimes niggles, but for less frequent drivers there's little to complain about.

CoPilot Premium UK & Ireland

Affordable, particularly its live traffic in-app purchase, but not as neatly presented as others

SCORE ★★★★★

PRICE £15.99



CoPilot Live offers a mid-budget solution for those frustrated by free apps, but unwilling to stump up for TomTom. The bargains start almost immediately – CoPilot's traffic system, ActiveTraffic, is free for the first year. It's a good system, too, accurately detecting nearby traffic and offering reasonable alternative routes. Furthermore, unlike some – such as Apple Maps and Waze – it showed a preference for major roads rather than dogmatically attempting to route us down completely traffic-free, windier roads. It also includes an accurate, up-to-date database of speed cameras.

CoPilot's map view is okay rather than good. It's more cluttered than Google Maps, less friendly than Waze, and lacks the best-of-both-worlds approach of TomTom, but it's easy to see what you need to do. That said, we also didn't feel that the next navigation – indicated by a mustard-yellow arrow at the bottom of the screen – was big enough, which means you'll be relying heavily on voice prompts. Other data, such as your ETA, is shown in small text on the right of the screen. It makes for a fairly cluttered approach that's bettered by others on test.

We did like the 3D lane alerts, though, with CoPilot displaying a



BELOW CoPilot's cluttered screen means you'll rely on voice prompts

simplified diagram of upcoming motorway splits. Voice navigation is pretty good as well: our biggest complaint is the omission of "the" from prompts such as "turn left at roundabout".

Its features offset these slight niggles: you can opt for a speed limit warning, with alerts available from overshoots as small as 5mph and as large as 30mph. Its POI database is also comprehensive. For inconclusive searches, you can also opt to search Google, Yelp and Wikipedia from within the app.

For iOS users, CoPilot is a tempting app. Half the price of TomTom and with free traffic detection, its less

intuitive interface is quite tolerable, although those putting in monster mileages are advised to spend the extra cash on TomTom's almost unerring display. For Android users, it's less appealing: with TomTom costing £34 for three years, including traffic, CoPilot isn't such a great deal. ●

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my DIGITAL CAM



There are mobile workers and then there are truly mobile workers. Sick of sitting behind my desk, day in day out, this summer I decided that I wouldn't drive to the office every day, but actually drive my office, giving me the freedom to work from almost anywhere I pleased. Ladies and gentlemen, may I present the digital camper van.

Everything starts somewhere, and with a project such as this, the base vehicle determines pretty much everything else. I opted for a 15-year-old, grey import Japanese MPV, the brilliantly named Mazda Bongo. As a starting point, it ticks all the right boxes, especially if you have the model with the electric raising roof for extra headroom. With only a tight budget to work with, however, I opted for the cheaper "tin-top" version, which is perfect for the kind of day trips or occasional weekend away that my usage requires.



LEFT The table folds out from the Bongo's kitchen unit



RIGHT When my phone is in Wi-Fi hotspot mode, I connect via a VPN for an extra layer of mobile security



PEEK VAN

Davey Winder reveals how he converted a Mazda camper van into a mobile office, complete with laptop chargers and high-speed internet

My Bongo came with eight seats that can fold flat to form a huge double bed, and a sliding door for access to the rear. I immediately reversed the middle set of seats to give me two rows facing each other and a roomier interior for relaxation or checking email. It didn't, however, provide enough space for comfortable laptop use and was crying out for a table.

A simple folding table popping out from the side of the van would do at a pinch, but it wouldn't provide the kind of dual-functionality I required. Instead, I removed the rearmost row of seats and replaced them with a kitchen unit. This comprises a gas-powered hob and a sink with pumped water from tanks below, meaning I could make coffee and rustle up vegan sausage sandwiches as required. Better yet, the addition of two wooden benches over the rear wheel arches (and attached to the kitchen unit) made for a better place to sit and type. The table, or desk, folds out from the kitchen unit between the benches. As

well as providing eating and working space, the table and benches combine with the remaining seats folded flat to form the bed. Much cheaper than hotels when overnight accommodation is required.

The Bongo already has blinds fitted for the side windows in the rear, and I've added some simple curtains to the rear window and to isolate the back from the cab. This makes it private overnight and keeps the harsh sun out during the day. I take a set of "thermal blinds", which sucker-cup onto the inside of the front and back windows, with me for those colder nights away.

POWERING UP

Most camper van conversions – the Bongo is no exception – end up with a mains electric hook-up fitted to provide 240v power to ordinary plug sockets. These obviously only work when actually hooked up via a long cable attached to a socket in your house or at a campsite – not ideal for getting a bit of work done when you find yourself parked

up in the middle of nowhere. That's where the addition of a leisure battery comes in. Unlike the regular starter battery, which provides a big burst of power to turn your engine over, the leisure battery provides a steady current. I've installed a split-charge relay system, which means that both the starter battery and the leisure battery are charged by the alternator as I drive along, meaning I always have power waiting for me when I park. That power is then used for the lights in the back of the van, the pump that delivers water from the storage container to the sink taps, the electric cool box that keeps my lunch fresh, and the combination of 12v and USB power sockets by my table.

These are rated at 1A and 2.1A respectively, which is the same kind of power you find on most home twin USB chargers. This means I can plug my phone and my tablet in when I stop and be sure they are always charged. That's essential when your tablet or phone is





ABOVE There are 12V and USB power sockets by my table, with 240V plugs available when hooked up on-site

also your internet hotspot (more on that in a moment). The same unit gives me a standard cigarette-lighter-style 12v socket, which I use to top up the laptop.

How so, given that no laptop runs on a 12v input? Rather than take the more expensive and somewhat overkill option of installing a power inverter to convert the 12v DC feed into a 240v AC one, I opted for an in-car laptop adapter that costs a fraction of the amount. For £25, I have an adapter that just plugs into my accessory socket and lets me dial up the output voltage I require. With the help of the bundled charging tips, this means I can happily charge my 19v work laptop when necessary. As a bonus, it's a totally removable unit, so can be used in other vehicles and as an aeroplane power adapter. Of course, the sensible course of action is to use as little external power as possible, which is where my Chromebook comes in to the picture.

BACK-OF-THE-VAN BROADBAND

I've opted for an Asus Flip C100P, which, as the name suggests, is a fully convertible Chromebook that switches from a laptop to a tablet in one smooth action. Not only does this mean I'm saving valuable space when on the road, since I don't need to carry two devices, but the ridiculous battery life (I can easily get a full eight hours of email, online research and word processing out of a single charge) does away with the need to worry about power sources on the move. It's a quick-charging device as well, getting me from 10% to three-quarters full in just an hour or so. That said, my to-do list has a solar panel installation on it to enable the sun to top up my leisure battery while I'm parked up (rather than requiring the engine to be running for the split-charge system to work), providing an eco-friendly source of power for my laptop.



ABOVE A £25 in-car laptop adaptor lets me dial up the voltage I require and charge my 19V battery when necessary



The Bongo is still a work in progress, with plans to add solar panels and convert the engine to LPG

That brings me onto connectivity, an essential for the Chromebook. There are all sorts of commercial internet solutions available for motor homes, most far beyond low-budget territory. I don't want to mount a satellite dish or aerial on the roof – the Bongo is tall enough without adding stuff to exclude me from even more car parks around the country. Instead, I made use of kit I already had.

My primary means of connecting to the internet is my phone, which is currently a Moto G running Android. I can run this in Wi-Fi hotspot mode when required. This functionality is easy to set up, complete with WPA2-PSK-protected access. I connect to it via a VPN for another layer of out-and-about security. As well as being secure, stable and simple to configure, this kind of mobile broadband setup is incredibly economical. I use a Three SIM that gives me 8GB of tethered data a month on top of my "normal" usage, at 4G speeds where available, for a little over £20 per month. Unless you're working in your vehicle every day, or have an uncontrollable video-streaming habit, that is more than adequate. What's more, since I can use my existing phone, there's no need to invest in additional hardware or contracts. It's the perfect mobile broadband

working solution for an office on wheels – unless you're parked somewhere where there's no Three signal, that is.

With this in mind, I invested in a PAYG fallback solution on a different network in the shape of an EE Buzzard in-car Wi-Fi unit. Rather than buying the latest hardware, I got a great deal on the older "version one" kit, which I picked up for less than £20, including £10 of data. This acts as a 4G USB Wi-Fi hub that plugs into the cigarette lighter socket. The 12v adapter comes off, too, leaving you with a standard USB-powered MiFi stick, which means you can use it in or out of the car. If the Three network lets me down, I simply plug the Buzzard into one of my kitchen unit USB sockets to use the fallback connection.

THE ROAD AHEAD

The Bongo, which I have named Jean-Claude, because it's a fine damn van, remains a work in progress. As I mentioned, there are already plans to add solar panels on the roof as an off-grid power source for the leisure battery and my assorted kit. My to-do list also includes a conversion of the "eco engine" to run off liquid petroleum gas (LPG), which is not only half the price of petrol, but produces minimal emissions. That just leaves in-van entertainment to sort out in the form of an Android Auto system. With suitable touchscreen head units now available for less than £500, better integration with phones and increasingly usable apps support, this has already moved up my list a notch or three. In the meantime, my mobile office is up and running. Having said that, I might just head back inside, at least until it gets a bit warmer again... ●



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Why work for someone else when you can make your own dream come true? The appeal of starting your own business is clear: you get to work on something you're passionate about and, if you're successful, potentially bank a couple of million pounds in the process.

Yet, for every Raspberry Pi, Skyscanner or Huddle, there are plenty more that don't succeed. A report from the RSA Group suggested at least half of all new businesses don't survive more than five years, while three-quarters of venture-backed firms don't return investor capital, according to Harvard Business School research.

That doesn't stop thousands of people every year from trying, though. "Tech entrepreneurs are entering one of the most exciting industries around," said Marko Balabanovic, innovation director at government-backed startup supporter Digital Catapult. "In 2014, 581,173 businesses registered with Companies House, while 98% of digital companies analysed in Tech City UK's recent report were small businesses. This also means competition is frenzied, and it takes a lot of determination to bring products or services to market. No road to success is smooth – there will be hurdles, but they can be overcome."

You'll need a good idea, the skills and wherewithal to make it happen, and plenty of luck. To make the road to startup success a little easier to traverse, we asked several leading British tech entrepreneurs to share their advice. Here's what it takes to find success – from those who have made it.



ALASTAIR MITCHELL | HUDDLE

"You need a team of people who can deliver the expertise and are top of their field"

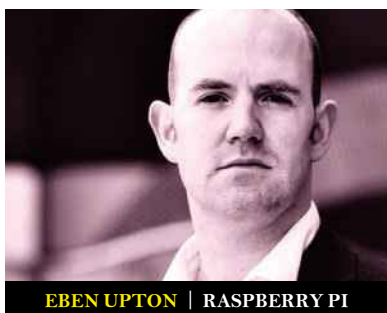


DEBBIE WOSSKOW | LOVE HOME SWAP

"Don't listen to anyone and everyone who tells you it will never work"

Top tips from tech ENTREPRENEURS

Starting a business is hard, particularly in the competitive tech industry. **Nicole Kobie** spoke to some of the UK's most successful tech entrepreneurs for advice



EBEN UPTON | RASPBERRY PI

“It’s much easier to sustain a high work rate if you believe in what you’re doing”



GARETH WILLIAMS | SKYSCANNER

“Create a shared vision of where you want to be as a company”



JESS BUTCHER | BLIPPAR

“Have a big-picture vision against which you plot your course, and keep referring back”

1 KNOW WHO'S IN CHARGE

Going into business with friends or former colleagues is fraught with risk, not least if there’s no clear hierarchy. Even Google co-founders Sergey Brin and Larry Page brought in Eric Schmidt to take over the day-to-day running of the company, before Page took the reins back in 2011.

Divide power, says Sara Murray, co-founder and CEO of home-care tech firm Buddi. She argues that 50-50 partnerships “don’t work,” adding: “Make it 51-49, because one day you’ll need the extra vote.”

Make sure the chain of command is clear, both internally and legally. “Seek legal advice from the start and have a clean structure,” said Serge Didenko, co-founder of modular smartwatch startup Blocks, which has raised \$1.5 million on Kickstarter. “Don’t obsess over details, but try to find a lawyer friend or a firm that can help you structure correctly.”

2 START EARLY

Got a great idea? Don’t sit on it. “Start today,” said Buddi’s Murray. “It takes around eight years for a business to become bankable. Don’t wait for a better idea – get started today.”

Blocks’ Didenko agrees. “Just do it,” he said. “It’s all about starting hands-on. If you wait for everything to be perfect, you’re never going to start. The perfect idea will come to you when you’re working on another idea. The perfect co-founder will come when you’ve already started working on it. Start doing something and then refine it.”

And that means starting young – if that’s still possible. “Do it early,” said Debbie Wosskow, founder of Love Home Swap, the travel home-swapping site. “Starting my first business at 25 meant I had nothing to lose.”

3 FIND THE RIGHT PEOPLE

Surrounding yourself with the right people is critical. It’s not only staff who have to buy into your company’s philosophy, but outsiders, too. “Take the time to assemble a really top-flight team: top-flight investors and top-flight customers and partners,” said Pilgrim Beart, founder of smart-home firm AlertMe and Internet of Things company 1248, among others. “Getting to success usually takes longer than you think, and there will be plenty of challenges along the way, so choose your fellow travellers carefully.”

Alastair Mitchell, co-founder and president of collaboration-software firm Huddle, says finding the right staff is the “classic struggle” for startups.

“You need a team of people who can deliver the expertise and who are the top of their field, whether it’s development, sales or marketing,” he said. “A truly successful team should also be full of founders: people who, when they do something, do it better than you could, rather than doing what they’re told. It’s really exceptional, but it makes the difference between an okay business and a great business.”

What does he look for when hiring? “People who think big, who are motivated and who have the entrepreneurial instinct,” Mitchell said. “In my questioning, I’m looking for almost the rough edges – the things on their résumé that look different or reveal an inner drive.”

The company culture your staff create can be the difference between success and failure, added Jon Reynolds, co-founder and CEO of the virtual-keyboard firm SwiftKey. “One of the most important things I’ve learned along the way is the impact of the people that you surround yourself with and the company culture that you cultivate together,” he said. “From the beginning, we’ve found that investing in great people is one of the best ways to grow the company and increase our chances of success.”



PILGRIM BEART | ALERTME

“Throwing mud at the wall can be a good initial strategy, but you have to pay attention to what’s sticking”



SARA MURRAY | BUDDI

“Learn to let people do things you know you could do better”



MARKO BALABANOVIC | DIGITALCATAPULT

“Tech entrepreneurs are entering one of the most exciting industries around”

4

DO WHAT YOU LOVE

One of the most successful tech ideas to come out of Britain in the past decade is the Raspberry Pi, a barebones microcomputer designed to encourage children’s interest in programming. Five million of the devices have been sold, but Raspberry Pi creator Eben Upton said he doesn’t measure success based on his bank balance. “It would seem kind of strange to start a business because you’ve got to make money,” he said. “You’ve got to think that you’re going to accomplish something that’s worthwhile.”

Upton insists it’s more fun this way. While that may sound flippant, he points out that it’s easier to sustain a productive work level if you enjoy what you’re doing. “Most startup companies fail... but one of the things that makes a difference is the work rate the people who have started the company can sustain,” he said. “It’s much easier to sustain a high work rate if you believe in what you’re doing. I don’t know many people who can sustain a high work rate because of the prospect of a big payday.”

5

TAKE YOUR HOLIDAYS

The stereotypical startup entrepreneur works 20-hour days, seven days a week, to make their dream come true. While there’s some truth to this, you’ll burn out if you don’t take a break. “When you’re working in situations that seem to demand you don’t take your holidays, I have learned to always take them,” said Celia Francis, CEO of Rated People.

“I remember, one summer, working the whole three months and finding myself completely burned out in the autumn as a result. I couldn’t bring my usual positive, creative, fun energy to my team, and it didn’t help me or the company succeed. And, of course, I missed a chance that will never come back to me to spend time with friends and family.”

Starting a business isn’t a three-month effort – you’ll be at it for years, so pace yourself. Some startups appear to become overnight successes, but it doesn’t normally happen straight away.

“Anyone who wants to pursue a startup in the industry needs to be prepared to make a holistic long-term commitment,” said Huddle’s Mitchell. “It doesn’t matter if you’re the founder, president or the CEO, you have to be in it for the long haul and you have to manage yourself, your health and your family life. That’s why I coach founders who are currently on this journey to encourage them to find a balance in their own lives. They need to learn how to manage the pressure and expectations they place on themselves.”

Finding work-life balance means ceding control. “Entrepreneurs become the bottleneck to growth because they struggle to delegate,” said Buddi’s Murray. “You have to learn to let people do things you know you could do better.”

Jess Butcher, co-founder of “visual discovery” browser Blippar, agrees. She said learning how to delegate “took me far too long, aided only by having a baby and an enforced period of time out.”

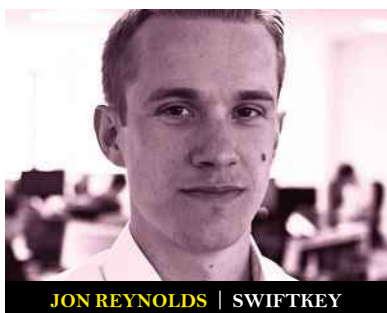
6

LISTEN AND COMMUNICATE

Those flappy things on the side of your head? Use them. “When you’re asking for people’s feedback, listen with open ears,” said Blocks’ Didenko. “Asking the correct question really matters in getting useful feedback that you don’t necessarily want to hear.”

But that doesn’t mean you need to heed every word of business advice. “Don’t listen to anyone and everyone who tells you it will never work,” said Woskow. “That’s an easy thing to say. Seek out people who will motivate and support – but also tell you the truth.”

Make sure you’re also telling customers and investors everything they need to know – they’re what will make you a success, after all. “At AlertMe we – correctly in my opinion – launched our proposition to market as soon as we possibly could, when it was barely in a beta



JON REYNOLDS | SWIFTKEY

“From the beginning, we’ve found that investing in great people is one of the best ways to grow”



CELIA FRANCIS | RATED PEOPLE

“Holidays – I have learned always to take them”



SERGE DIDENKO | BLOCKS

“Just do it. If you wait for everything to be perfect, you’re never going to start”

stage. This was fantastic for shaking out bugs in the technology, the UX and the proposition,” said founder Beart. “But we hadn’t realised how clear we needed to be with our B2C early adopters that this was indeed a beta, so we had to do a lot of damage limitation, since we initially failed to meet their expectations. If we had set clearer expectations upfront, I think we could have saved ourselves a lot of pain and still had a lot of good learning.”

7 HAVE A VISION

What’s the goal of your startup? Does it scale to tens of thousands of users and hundreds of staff? “The importance of creating a shared vision about where we want to be as a company is as vital now, with a team of over 700, as it was when there were three of us working from my spare room,” said Gareth Williams of Skyscanner, the booking site that has disrupted how web-savvy travellers find discount flights. “I strongly believe time can barely be wasted in the communication of vision and strategy.”

And while you need to be flexible with that vision, so it can evolve as you learn, make sure you stay focused, advises AlertMe’s Beart. “I caused a lot of problems for my first startup because I repeatedly rushed after the latest, most exciting opportunities. I should have worked out which was the most important one and stuck with it,” he said. “Throwing mud at the wall can be a good initial strategy, but you do have to pay attention to what’s sticking.”

The vision for your startup may be so grand that it’s intimidating. “Don’t let yourself be overwhelmed by the task ahead and use that as a reason not to start,” said Blippar’s Butcher.

“Have a big-picture vision against which you plot your course and keep referring back, but break it down into a micro to-do list and start ploughing through it. You’ll be amazed at how prolific and productive you can be when that to-do list is for your personal vision and not someone else’s.”

8 CHECK YOUR ATTITUDE

Of all the qualities required of a startup entrepreneur, mental toughness is near the top of the list. “This stuff is hard,” said Love Home Swap’s Woskow. “It requires grit. The staying power matters more than the initial enthusiasm that comes with the idea.”

She and our other entrepreneurs offer advice that holds true to the rest of life: get up early; never burn a bridge; develop a thicker skin; keep trying. “If you feel like every day you have tried to be the best you can be, that’s a reason to bounce out of bed the next morning,” Woskow said.

9 NO REGRETS

Don’t forget that you chose to start a business – this is your dream, and yours to shape. Throw yourself into it so you’ll never look back and wonder “what if?” Huddle’s Mitchell has a test for ensuring he avoids regrets: how would he feel if he were hit by a bus? Other than squashed, that is.

“One of the guiding principles in my life – and everyone I know gets very bored hearing me talk about it – is what I call the big, red bus,” he explained. “It’s basically about the fear of death.”

“The idea is to think about what would happen if I were to walk out across the street and be struck by a big, red bus. In that brief moment before it hits me, what would be the thing that I would regret not having done?”

“Instinctively, people know the right answer, but it can be buried under so many layers of doubt and questions that it’s sometimes hard to find,” he added. “Starting my own business came from one of those moments. I just decided one day that I was going to do this. It was at the height of everything going well for me in my job, but I knew if I were staring down the big, red bus without having gone for it, I would regret it.” ●



Turn a £49 webcam into a security camera

Inexpensive webcams are an excellent way to add security to your home and office. **Nik Rawlinson** shows how – and explains the pitfalls

It's not long since setting up a video surveillance system involved a lot of time, money and mess. Time because it was complicated; money because you had to invest in some hefty kit; and mess because it invariably required drilling, cable-feeding and housing a recording device.

Not any more. Modern webcams, which are cheap, flexible and easy to install, do just as good a job. They often boast high resolutions, night-vision and – a real bonus – remote control using simply a browser and a broadband connection.

In this hands-on walkthrough, we're going to explain how to set up your own office or home security system using a cheap, easily configured internet protocol (IP) webcam. We've specified an IP camera, rather than one that connects to a PC over USB, because IP webcams connect directly to a router and so can stream to the web when your computer is turned off.

■ Candid camera

By their nature, webcams can reveal a lot about you – and anyone else they can see. Before you go any further, you need to secure your camera with a robust password.

Many manufacturers ship their webcams with default login credentials, which are often the same on all models. Unless you change them, anyone who can determine what kind of camera you're using will also be able to access your live stream, since the passwords are only a Google search away.

In February 2015, Stephen Eckersley, head of enforcement for the Information Commissioner's Office, wrote to IP camera manufacturers, impressing upon them the need to make their customers aware of the risk they run in setting up an IP camera without changing the default details.

His letter (pcpro.link/256ipcsm) highlighted Insecam, a site that streams live footage from insecure IP cameras. Is the site doing anything wrong? Maybe not – it isn't hacking in to anyone's camera, after all. Still, to avoid having your stream appear in its list of links, change the password through the camera's built-in config pages.



At one point, Insecam was streaming more than 73,000 cameras, plus details of the manufacturer, the model and the approximate location. This represented, in Eckersley's words, "a major breach of privacy and data protection rights [that] was extremely concerning for us and many

“ Cameras should not be deployed as a quick fix, but a proportionate response to a pressing problem ”

other global data protection authorities". He requested that the manufacturers to whom the letter was sent built in prompts asking users to change the username and password on their device before it was used.

■ Is there a better solution?

The ICO can impose fines of up to £500,000 for serious breaches of the Data Protection Act, so it's worth familiarising yourself with its guidance. Much of this is common sense,

such as keeping cameras out of changing rooms, but it's still worth reading in full (pcpro.link/256ccctv).

It's also important to think carefully whether a camera is the best solution to a perceived problem. For example, might better security lighting achieve much the same result? Also, be careful where you position any equipment: ensure you record only relevant footage and minimise overspill into other, private areas.

"Surveillance cameras should not be deployed as a quick fix, but a proportionate response to a real and pressing problem," the ICO explains. "[Before] putting in surveillance cameras... you need to understand the problem and whether that is an effective and proportionate solution. Failure to do proper privacy impact assessments in advance has been a common theme in our enforcement cases."

As long as you're happy with this, the following 12 steps are all you need to know to set up your own security system at minimal cost. The process should take around two hours to complete.

Setting up a webcam surveillance system in 12 steps

1 We're using a Foscam FI8918W wireless webcam with night vision because it's relatively cheap (£49 on Amazon) and can be controlled through the browser. This means you can pan and tilt to get a better look at its surroundings from wherever you happen to be. A lot of rivals devices are similar. The key is to look for a camera that connects directly to your network by Wi-Fi or Ethernet and has a built-in web server.



2 Position the camera, balancing good coverage with respect for others' privacy. Avoid any bright lights between the camera and the target area. Keep it out the way of pets or they will activate motion detection. Most cameras ship with a 0.75in bracket: don't worry if the only practical location for mounting this is under a worktop or shelf, since there's normally a "flip" option to re-orient the image.

192.168.2.1/login.cgi

BELKIN Router Setup

LAN Setup
LAN Settings
DHCP Client List
Internet WAN
Connection Type
DNS
MAC Address
Parental Controls
Website Filters
Wireless
Channel and SSID
Security
Wi-Fi Protected Setup
Use as an Access Point
Firewall
Virtual Servers
MAC Address Filtering
QoS

LAN > DHCP Client List

This page shows you the IP address, Host Name and MAC address of each computer that is connected to your network. If the computer does not have a host name specified, then the Host Name field will be blank. Pressing "Refresh" will update the list.

IP Address	Host Name	MAC Address
192.168.2.7	unknown	00:0b:82:1d:28:a4
192.168.2.8	ipcam_000DC5D36	00:0d:c5:d3:67:8f
192.168.2.3	WIN-4IMOO11QSBT	24:0a:64:4b:8c:16
192.168.2.2	Niks-Mac-mini	88:53:95:29:7a:91
192.168.2.4	Niks-Mac-mini	a8:20:66:35:16:c2
192.168.2.5	Niks-iPad-mini	e4:8b:7f:a1:5e:d9

3 Open your router control panel by typing its address into a browser (find it by typing "ipconfig" at the Windows command prompt and using the address beside "Default Gateway"). Click through to the list of devices attached to the router to find the camera's address. Type this into your browser to open the camera's web server. Change the username and password if necessary, then move on to the camera's network settings.

Real-time IP Camera Monitoring System

Device Status
Live Video
Device Management

Alarm Service Settings

Motion Detect Armed ☒

Motion Detect Sensibility 10

Motion Compensation ☐

Send Mail on Alarm ☒

Upload Image on Alarm ☐

Scheduler ☐

Submit Refresh

5 Reboot the camera, then log in using its new IP address. In the config pages, look for an alarm service (possibly called "Motion Detect"). Check the option to activate motion detection, then decide whether you want it to email an image of the detected movement, upload it using FTP or both. We want to receive an email, so check that box, click "Submit to confirm", wait for the camera to reboot and return to the config pages.

Device Status
Alias Settings
Date & Time Settings
Users Settings
Basic Network Settings
Wireless LAN Settings
ADSL Settings
UPnP Settings
DDNS Service Settings
Mail Service Settings
MSN Settings
FTP Service Settings
Alarm Service Settings
PT Settings
Upgrade Device Firmware
Backup & Restore Settings

Basic Network Settings

Obtain IP from DHCP Server ☐

IP Address 192.168.2.8

Subnet Mask 255.255.255.0

Gateway 192.168.2.1

DNS Server 192.168.2.1

HTTP Port

Network Lamp ☒

Submit Refresh

4 To access the camera remotely, we need to fix its address on the local network. This way, we can route requests to it directly from our broadband connection. Uncheck the camera's DHCP option and assign it an address that's not in use on your network. Enter the "Default Gateway" data from ipconfig in the gateway and DNS server boxes, plus the subnet mask (also from ipconfig) in the appropriate field.

Real-time IP Camera Monitoring System

Device Status
Live Video
Device Management

Mail Service Settings

Sender

Receiver 1 nik.rawlinson@gmail.com

Receiver 2

Receiver 3

Receiver 4

SMTP Server smtp.gmail.com

SMTP Port 465

Transport Layer Security TLS

Gmail only support TLS at port 465 and support STARTTLS at port 25/587.

Need Authentication ☒

SMTP User

SMTP Password

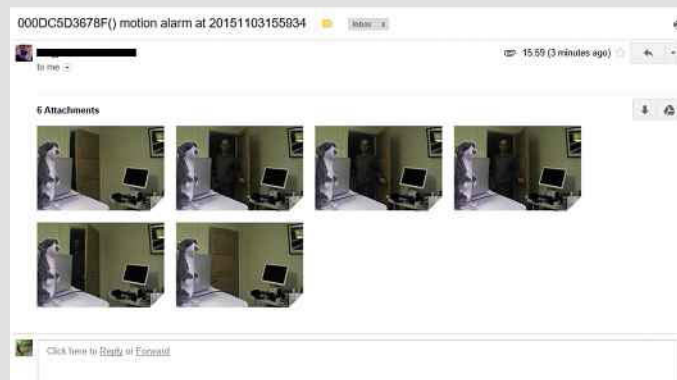
Test Please set at first, and then test.

Report Internet IP by Mail ☐

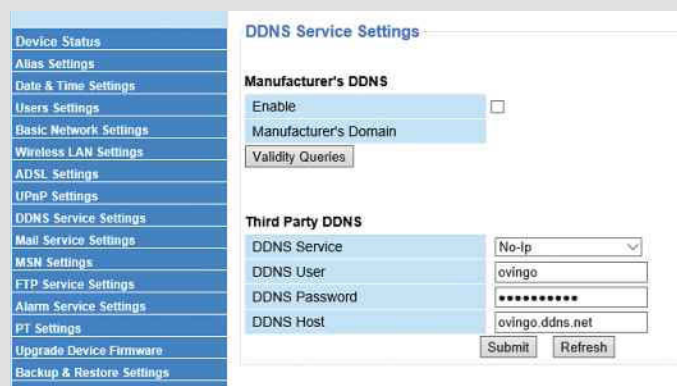
Submit Refresh

6 Open the mail service settings and tell the camera who should receive the images and how it should send them. We're going to send them to one person, so we've entered their address in the appropriate box, adding the sending address. We then need to add the SMTP server, SMTP port, username, password and security options in the boxes at the foot of the page to match the "from" address.

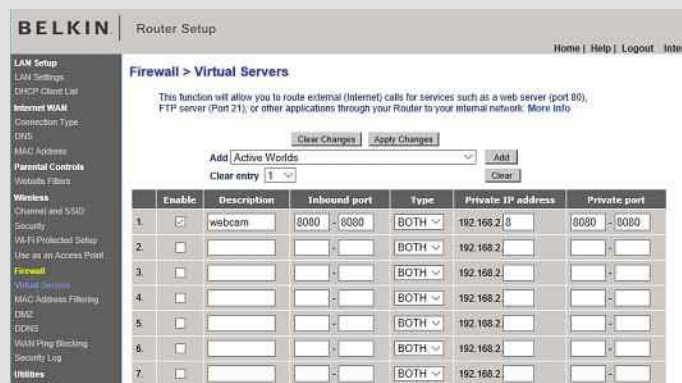
Setting up a webcam surveillance system in 12 steps



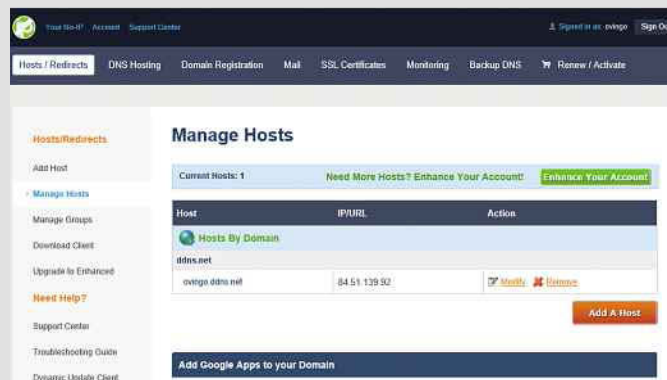
7 The easiest way to test the motion detection is to walk in front of the camera, then refresh your email inbox. If an email doesn't appear and you're sure the camera's settings are correct, check your spam bin: that's where ours ended up the first time we tested the system. If there's nothing there, return to "Alarm service Settings" and adjust the "Motion Detect Sensitivity" option so that it triggers with less movement.



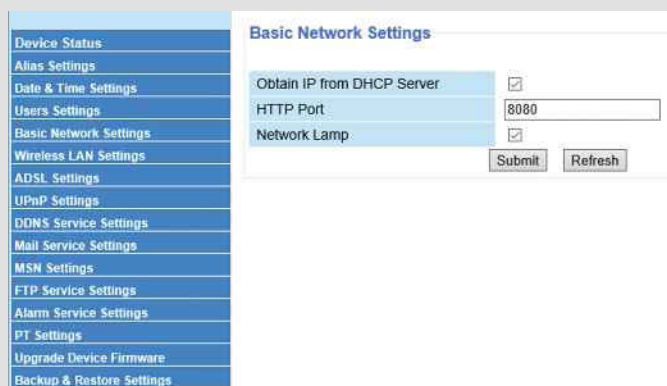
9 We need to add this host name and our No-IP credentials to the camera configuration, so it can log in to the account and update the system when it detects a change to our router's IP address. Return to the webcam configuration pages, open the DDNS settings and select the service you're using. Enter the username, password and host you specified during setup, then save the changes and wait for the camera to reboot.



11 The camera now knows what to do when it receives an incoming connection, but we haven't built the bridge between it and the router. We'll do this by logging in to the router again, opening virtual servers (sometimes called port forwarding) and adding an entry to direct incoming connections on port 8080 to our camera's IP address. We have also specified 8080 for the private port to match the settings on the camera.



8 We need to set up full remote access so we can view the live video online without having to wait for the motion-detect system to trigger. We'll use a dynamic DNS service that our camera can update every time it detects its broadband IP address changing. Our camera supports No-IP, so we've signed up for a free account at noip.com and picked the subdomain "ovingo.ddns.net" (using your own domain is chargeable).



10 We're also running a server on our network, which we want to access through the regular HTTP port (80). To avoid confusion or any tricky internal rerouting, we'll adjust the camera's web server so it's accessible through port 8080. To set this up, we return to the "Basic Network Settings" and enter 8080 in the HTTP port box, but leave all of the other settings, as entered in step 4, as they are.



12 Now that the router knows where to send requests, when we type ovingo.ddns.net into a web browser it will update to the last known IP address the webcam supplied to the No-IP service, with "8080" tacked on to the end. The router will spot this, reroute the request through the internal network to the camera and let you – or anyone with the password – log in and control it remotely. ●

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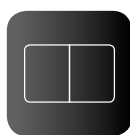


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FEATURES



DIY smart home

Is it really practical to build your own smart home using off-the-shelf equipment? We find out if the various smart home gadgets can talk to one another and whether they really make your domestic life effortless.



Vivaldi: the new Opera?

After an acrimonious split from Opera – the browser company he co-founded – Jon von Tetzchner is back with a new browser, Vivaldi. Find out all about the feature-packed browser designed for IT enthusiasts.



You're wasting your life

Working longer hours doesn't necessarily mean working better – in fact, the evidence suggests those late nights at the office are harming your performance. Find out how to stop the rot and monitor your performance.



Virtual machines on Windows 10

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Apple iPad Pro

Apple's new flagship, with its excellent Smart Keyboard and Apple Pencil, is an eye-poppingly good tablet and a capable laptop

SCORE ★★★★★

PRICE 32GB, £566 (£679 inc VAT)
from apple.com/uk

This year, for the first time since 2010, Apple didn't update its flagship iPad. Except it did. Suddenly, the iPad Air 2 isn't Apple's classiest tablet any more. It's been overtaken by a more advanced, bigger brother.

The iPad Pro has just gone on sale, and I've been putting it through its paces for more than a week to see if it lives up to the hype – and price tag.

■ Design

One glance tells you this is an iPad, thanks to its glass front, aluminium rear, chamfered-edges and all-over immaculate build quality. It has an identical design to the iPad Air 2 and

iPad mini 4. The front is all display, surrounded by narrow bezels on the longer sides and wider ones at top and bottom. A camera lens peeps out from the centre at the top and the home button with Touch ID capabilities nestles at the bottom.

Almost every other detail is the same as on the smaller-screened Apple tablets. Power button on the top edge: check. Volume buttons on the right edge: check. Whacking great Apple logo on the middle of the back: check. On the Wi-Fi and cellular model, plastic stripe on the back and SIM card slot on the right edge: check and check. Single loudspeaker on bottom edge: hold on.

The iPad Pro, uniquely in Apple's iPad range, has four speakers: two on the top and two on the bottom edge. As you'd imagine, this design change really upgrades the tablet's audio capabilities.



There's another difference: on the left edge, three small circles sit innocuously in the middle. These form the Smart Connector, which attaches to the Smart Keyboard or third-party accessories such as the Logitech Create keyboard case.

For all the similarities, the Pro has one major difference to previous iPads: its size. The 12.9in display may not sound much bigger than the previous iPad's 9.7in screen, but it looks huge in comparison.

It's much heavier than the iPad Air 2, but still lighter than the first iPad, weighing 713g for the Wi-Fi-only edition, and 723g for the Wi-Fi and 4G model. It's heavier than many rival tablets, but still feels light for its size.

■ Display

The 12.9in, 2,732 x 2,048 display has the same pixel density (264ppi) as the iPad Air 2. It's a Retina display so it's

pin-sharp and, as with most Apple displays, bright and colourful.

As always, this is an IPS LCD screen, not AMOLED, so colours aren't overblown or oversaturated, and it has the same anti-reflective coating as the iPad Air 2, making it readable even in bright light.

What really stands out is the size of the screen. It's as wide as the iPad Air 2 is tall, meaning there's a lot more space on offer. When you're working on a video-editing app, this gives you a good-sized video window, along with the editing timeline below. If you choose the multitasking Split Screen view, where you can have two simultaneously active windows side by side, both windows are substantial and usable.

If you're using the iPad Pro to consume rather than produce content, it's a joy. Video playback is smooth and really shines on this display. Plus, the four speakers add a beefy sound that's better than any previous iPad's. The tablet reaches high volumes and the stereo effect is clearly discernible.

Intriguingly, when you turn the tablet from landscape to portrait, the iPad switches the orientation of the speakers so the left channel continues to come from the two speakers on your left.

Smart Keyboard

The Smart Keyboard is one of two essential peripherals for the iPad Pro. Just as the Type Cover hugely improves Microsoft Surface tablets, the dedicated keyboard turns the iPad Pro into a successful laptop substitute. Tim Cook recently said that, although he still loves his Mac, when he travels he takes the iPad Pro as his computer.

In some ways this keyboard is better than Microsoft's Surface keyboard because the keys (which, at first glance, look like they may not be up to much) are superb to use: firm but responsive and comfortable, even when used for long periods.

The base is solid enough for you to have it on your lap, too, but the big problem is that it can only prop up the iPad Pro at one angle. You may find this fits with your way of working, but there will almost certainly be a situation in which the tablet doesn't quite work perfectly.

Another issue is that, for now, only the US keyboard layout is available, although it's still

possible to use it as a UK layout if your iPad is set up that way. This means the £ sign is right where it should be, even if the physical key shows the # symbol.

Other layouts will soon follow and Logitech's cover is already available. It's a little cheaper than the Apple model at £110 and even has backlit keys, but isn't as classily made. Still, it also covers the back of the iPad Pro, meaning it's better at protecting your hardware.

Apple Pencil

The Pencil is Apple's answer to the stylus. It's slim, perfectly weighted and a quintessential Apple beauty: sleek, elegant and highly effective.

If you've ever used a stylus with an iPad, forget everything you know: the Pencil is nothing like that experience. While using a stylus is a bit laggy and imprecise, the Pencil is fast, responsive and clean. Latency is, according to Apple, under 20ms – which means you don't notice it at all in the real world.

Unlike most capacitive styluses, it has a slender nib, which is firm rather than squashy to the touch. That's because the tip of the Pencil, like some styluses from Wacom and N-trig,

ABOVE The dedicated Smart Keyboard turns the iPad Pro into a laptop substitute

includes sensors that recognise pressure. Apple hasn't revealed how many pressure levels the Pencil can spot, but it certainly has a satisfyingly realistic feel to it. More than any other stylus I've used, it feels like using a real pencil on paper, with just the right amount of slide and friction. Tilt the Pencil on its side and you can even add shading as you draw.

Several things about the Pencil show off Apple's attention to detail. The cap, which covers the Lightning plug used to charge it, has a small

metal ring and snaps to the top in a really satisfying way.

Apple has also thought through the practicalities. The top slides off to reveal an extended Lightning connector. This is used to pair the two and charge the

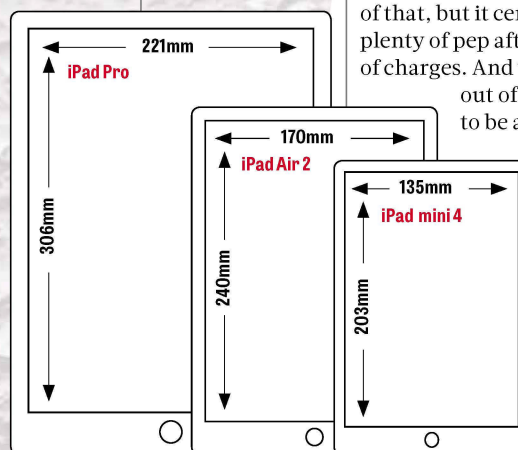
Pencil – and it doesn't need long to deliver a useful amount of charge. In fact, Apple says that 15 seconds of charging will give 30 minutes of use.

I can't vouch for the accuracy of that, but it certainly seemed to have plenty of pep after the briefest of charges. And when it does run out of juice, it's reassuring to be able to revitalise it in

less time than it takes to make a cup of tea.

One negative point here is that there's no sleeve or cavity in the iPad Pro or the Smart Keyboard to store the Pencil, so be careful you don't lose

"If you've ever used a stylus with an iPad, forget everything you know: the Pencil is nothing like that"



RIGHT The Apple Pencil is slim, perfectly weighted and a quintessential Apple beauty

it. Moreover, at £79, it's far from cheap, but if you want to make the most of the Pro, it's definitely a purchase worth considering.

Plenty of apps have already been optimised for the iPad Pro's bigger screen and delicate Pencil. Apple's own Notes app is a joy to sketch on, especially with the virtual ruler, which offers spectacular precision.

However, the Pencil isn't perfect. One of the characteristics of the way a real pencil works is its interaction with the material, and, in particular, the way the pencil drags when pushed or pulled across the surface. There's currently no real way that Apple can change this, as the screen has to be flat and smooth, but it remains the best approximation of a pencil on paper that anyone has yet come up with.

■ Performance and battery life

Apple has included its most powerful processor yet in the iPad Pro. The A9 chip found in the latest iPhones has been beefed up with an X, and the iPad Pro also has extra RAM.

Whatever the specs, this is a tablet that feels consistently nippy and responsive. Even when editing video at 4K resolution, the iPad Pro didn't slow down. Tasks from video playback to side-by-side email and web surfing were swift and easy to accomplish.

Apple has said that it's faster than many portable PCs, including a few MacBooks, and the benchmarks seem to confirm this. For example, a high Geekbench 3.1 single-core result of 3,192 and a multi-core result of 5,413

are both significant improvements over the iPad Air 2.

I also ran the GFXBench Manhattan tests, which delivered results of 33fps for the onscreen test and 79fps for the offscreen test, run at 1080p. Again, these are seriously impressive results: faster than any Android or iOS tablet we've ever tested, and faster even than a mid-2014 MacBook Pro 13 equipped with Intel's integrated Iris Graphics 6100.

That said, one of Apple's guiding principles has always been to avoid statistics and instead focus on delivering a flawless user experience. And this is most certainly the case here.

The other important indicator of performance is battery life, and that's an area in which Apple's iPads have always been consistently good. There's a large, rich screen to service here and one heckuva big battery to power it – a 38.5Wh battery, to be precise. And in our video-rundown tests, the iPad Pro performed admirably, lasting a solid 9hrs 8mins (in flight mode, with the screen set to a brightness of 170cd/m²) before expiring.

■ Verdict

The iPad Pro is a stunning machine. It looks fantastic and, once you get over just how big it is, the size becomes a benefit, with its immersive screen and giant playground of real estate for apps to exploit.



ABOVE The Apple iPad Pro's large Retina display is pin-sharp, bright and colourful

Add Apple's Smart Keyboard or a rival setup and you have a great laptop alternative, with a decent battery life and an unparalleled choice of many big-screen, touch-enabled apps. The Pencil adds a whole new dimension of usability and is an enjoyable peripheral to use.

It's expensive, though: add it all up and you're spending more than £800 for the full set of tablet, Pencil and Smart Keyboard, and you can pay even

more to boost storage from the stock 32GB to 128GB. But, despite this, the iPad Pro is not bad value at all. For your money, you're getting a fast, capable laptop running on iOS, and an eye-poppingly good tablet with ear-tingling audio to boot.

The iPad Pro marks another major inflection point: it ends the whole "iPads are only for consumption" debate. The only people who can't use the iPad Pro as a creation tool are those who need really high-end performance: professional graphic designers and video editors – the kind

of people for whom 16GB of RAM is table stakes.

Most people don't fall into that category, and the iPad Pro is more than sufficient as a creation tool. For some users – anyone who sketches or

loves using a stylus – it's a better creative tool than your average PC or laptop.

Overall, it's worth seeing if the iPad Pro's size and weight suits you. There are other smaller, lighter and much cheaper iPads. But, if the large size appeals, the new Apple flagship is hard not to like. **DAVID PHELAN**

"It's faster than any iOS or Android tablet we've ever tested and is even faster than a mid-2014 MacBook Pro 13in"

BATTERY: video playback, 9hrs 8mins



SPECIFICATIONS

Apple A9X processor • M9 motion coprocessor • 32/128GB storage • 12.9in 2,732 x 2,048 IPS display • 802.11ac Wi-Fi • 4G (optional) • 38.5Wh battery • iOS 9 • 1yr RTB warranty • 221 x 7 x 306mm (WDH) • 713g

LEFT The iPad Pro is almost as wide as the iPad Air is tall



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Microsoft Surface Pro 4

The Surface Pro 4 is mostly an iterative improvement, but don't underestimate how good that makes it

SCORE ★★★★★

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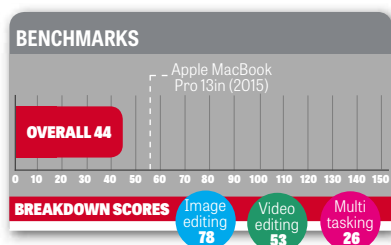
The Microsoft Surface Pro 4 takes the tried, tested and rather likeable Surface Pro 3 form and improves almost every aspect of it. It's an iteration over its predecessor, but don't make the mistake of thinking that the improvements are "only" iterative. As Apple has proven time and again, constant iteration leads to products that end up head and shoulders above the competition. And that's where the Surface Pro 4 is.

In case you haven't seen a Surface Pro, or you somehow missed the huge multimillion-dollar advertising campaign Microsoft has run since the first one launched, it's designed to be the tablet that can replace a laptop. It runs Windows 10, so you can use the full gamut of Windows applications, and it's based on an Intel processor – in our case, the latest Skylake Core i5-6300U – although you can go up to an i7, or even step down to a Core m3.

Prices run from £749 inc VAT for the m3 model with 4GB of RAM and a 128GB SSD, up to £1,799 for an i7 with 16GB of RAM and a 512GB SSD. As usual, you'll have to add on £110 for the (pretty much essential) Type Cover, which means a top-of-the-range Surface Pro 4 won't leave you much change from £2,000. Microsoft is truly following the Apple sales model with this one.

■ Design and build quality

This isn't to suggest poor value for money: you're getting design and build quality that's at least as good as Apple's here. And, although the design of the Surface Pro 4 doesn't stray too far from that of the Surface Pro 3, there are tweaks Microsoft has made that improve it.



There's still the same ingenious stand, which you can adjust to almost any angle, so it's close to being a laptop-like experience. Compare this with the iPad Pro's keyboard stand, with its one-size-fits-all approach, and you really appreciate Microsoft's design skills.

The body is the same as its predecessor, as are the ports: USB 3, DisplayPort, and a microSD slot hidden are under the stand. Microsoft hasn't taken the opportunity to shift to USB Type-C, which I think is a shame. This means we're also stuck with the weird proprietary power connector, rather than being able to charge from USB Type-C. Perhaps next time.

One small design tweak that's welcome, though, is the addition of a few magnets on the left-hand side. These hold the Surface Pen – which is included – firmly to the side of the device. How firmly? Firmly enough that, on a flat desk, I can drag the device along just by holding the pen and pulling. It's not quite as secure as an internal docking slot, but it's close.

The biggest question mark over the design remains its "lappability", as Microsoft has taken to calling it. As with the Surface Pro 3, the 4 is helped by the stand's ability to tilt the screen to a wide range of angles. However, while it's now steady, it's still deeper than using a conventional laptop, which means people who have short legs are likely to find it less comfortable.

Ultimately, it comes down to you. If you spend a lot of time using your current laptop on your lap (say, on the train), the Surface Pro will be less suitable for you. If, on the other hand, you're likely to use it on a table or desk, it will be perfectly fine.

ABOVE We love the screen's eye-popping brightness and contrast levels



■ Type Cover

I didn't hate the Surface Pro 3's Type Cover. I could happily type on it for hours, but was always pleased to get back to a proper keyboard. It wasn't so much the size of the keys or the travel, but the slight flex that you felt when you hit it.

The good news is that Surface Pro 4's Type Cover largely fixes this. Microsoft has added some much needed rigidity to the cover – it's actually hard to bend now – which means the keyboard doesn't bounce in quite the same alarming way. The keys themselves are still a bit clicky, but it's a nice experience, and I'd be happy to type on it all the time.

The trackpad has also been improved. It's now a little bigger, and topped with glass, with a much-smoother feel. It's moved from the "I want a mouse now, please" category to "I can use this".

It's helped by a few nice extra touches. For example, the function key now has a tiny light and acts as function-lock. The backlighting has also improved, although the keys still leak more light than they should.

The Surface Pro 4 keyboard works with the Surface Pro 3 as well. So, if you have an older Pro, I'd definitely recommend running out and buying one as soon as you can.

■ Screen

The screen has had plenty of attention lavished on it. As with the Surface Pro 3, the Surface Pro 4 has a ten-point touchscreen, which is fast and accurate. However, the resolution has been upped to 2,736 x 1,824, which translates to a pixel density of 267ppi,

"The Surface Pro 4 isn't poor value for money: you are getting design and build quality that's at least as good as Apple's here"

and this means absolutely everything looks super sharp and clear, even to old eyes like mine.

And there's more good news. We measured the brightness at 388cd/m², which is great, while contrast hit 1,218:1, which is absolutely superb. Likewise, colour accuracy and sRGB gamut coverage was difficult to fault. In short, the screen on the Surface Pro 4 is amazing.

Performance and battery life

Microsoft talks about the Surface series as being "no compromise" machines, but whenever you're creating a compact, light device, the laws of thermodynamics mean that compromises are inevitable. You can make a compact computer fast, long-working or cool – but you can't do all three at the same time.

The compromises Microsoft has made with the Surface Pro 4 are reasonable, and similar to those of the Surface Pro 3. It's a little faster than this year's MacBook Air, but in our battery tests gave out after 5hrs 41mins. Out in the real world, you'll

BATTERY: video playback, 5hrs 41mins



probably squeeze about seven hours of normal use out of it – not quite a full day, but close. For the record, Microsoft claims a nine-hour battery life for video playback.

Certainly, all-round performance is good rather than stellar. An overall score of 44 in our benchmarks is some way behind the latest MacBook Pro 13in. This kind of performance from the i5 version makes me wonder how well the Core m3 option performs – my gut feeling is that it's likely to be a disappointment.

Pen upgrade

There's one obvious difference to the pen on the Surface Pro 4: an all-new eraser on top. As with a regular pencil, you just flip the pen over and rub onscreen to erase things. As before, clicking on the pen top launches OneNote, while double-clicking allows you to grab part of the screen and capture it into OneNote. New, however, is the ability to do a long press to launch Cortana. According to Microsoft, the screen and pen are more sensitive too: the Surface Pro 4 is now capable of sensing 1,024 levels of pressure, instead of 256 for the Pro 3.

The shape of the pen has also changed a little: there's now a flat side, allowing it to stick more securely to the magnets on the Surface.



ABOVE Super-strong magnets connect the upgraded Pen to the side of the Surface

Verdict

I liked the Surface Pro 3 enough to buy one after reviewing it last year. The Surface Pro 4 is a step up, and it's going to be hard stepping back to the Surface Pro 3 again. The screen is amazing, the keyboard has improved and the small design touches all gladden the heart.

That said, it's not the perfect machine. I'd like to see a few more hours of battery life, so I can take it into work without reaching for the power adapter. It's expensive, too. Spending £1,200 on an i5-based machine with 8GB of RAM and a 256GB SSD gives pause for thought. It's a lot of money to spend.

Overall, though, Microsoft really is pushing the Surface Pro line along nicely. There isn't quite enough here to make me want to upgrade from a Surface Pro 3, but it's a good, solid update, and it remains the hybrid that sets the standard. **IAN BETTERIDGE**

SPECIFICATIONS

Dual-core 2.4GHz Intel Core i5-6300U • 8GB RAM • 256GB SSD • 12.3in 2,736 x 1,824 IPS touchscreen display • Intel HD Graphics 520 • microSD slot • USB 3 • mini-DisplayPort • 5MP/8MP front/rear cameras • 802.11ac Wi-Fi • Bluetooth 4 • 5,087mAh Li-ion battery • Windows 10 Pro (64-bit) • 1yr RTB warranty • 292 x 8.5 x 201mm (WDH) • 786g

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Chillblast Fusion Krypton

A beast of a machine that will pile through games and demanding tasks while barely making a whisper

SCORE ★★★★★

PRICE £763 (£916 inc VAT) from chillblast.com

There's a reason why British-made PCs remain popular with enthusiasts: our PC makers are always willing to push the limits, to build something with a bit extra. For evidence, just compare and contrast the Chillblast Fusion Krypton with anything you can buy from Dell, HP or even Alienware. Or let me save you some time – you won't come close.

Not everyone will love the Krypton's design. One member of the *PC Pro* team said it looked like a shredder on steroids, while another loved its "space-age" looks. Beauty, as ever, is in the eye of the beholder. One thing I can say with confidence is that it's striking: few people will walk past this PC without passing comment.

That's especially true if you keep the Krypton in a dark room, where the subtle blue light behind the grille gives it a futuristic glow worthy of a Spielberg film. The illumination belongs to the stonkingly huge fan – 200mm in diameter – that ensures the case insides are kept cool with minimal noise. Amazingly, despite its five fans, including two on the graphics card alone, this machine is whisper-quiet in operation.

This peace belies the beast within, with Intel's 3.5GHz Core i5-6600K overclocked to a stable 4.4GHz. If you want to push it further, the Asus Z170M-PLUS microATX motherboard offers the wealth of features we've come to expect from game-focused boards, with Asus' "EZ" and Advanced modes on offer depending on your level of knowledge.

The Asus board offers four DDR4 sockets, with Chillblast generously providing two 8GB Corsair 2,133MHz DDR4 DIMMs. Factor in the 256GB



While there isn't very much room to manoeuvre inside the case, upgraders will appreciate the swing-out bay that contains two easy-slide-out caddies for 2.5in drives, and the way Chillblast's engineers have pre-routed the connectors so it's just a matter of plugging them in. Two more 5.25in bays sit empty at the top, with one external slot cut into the fascia for an optical drive. It's super-easy to access these bays, too: the grille at the top of the case simply lifts off.

Equally convenient are the three USB ports mounted on the front lip

M.2 Samsung SM951 SSD and we expected this system to fly through our benchmarks. And fly it did. A score of 136 is the second fastest we've seen, a single point behind Chillblast's own Fusion Centurion (see issue 252, p64). This PC will cope with whatever you demand of it.

The same is true for games. The graphics card not only looks the part when gazed at adoringly through the windowed side of the case, it delivers thumping performance too. Key to its speed is Nvidia's GeForce GTX 970 chipset, which offers a staggering amount of power: this PC scored 55.1fps in the demanding Heaven benchmark from Unigine (1,920 x 1,080, 8x anti-aliasing, top quality settings) compared to 31.5fps from the GeForce GTX 960-powered Yoyotech Warbird we reviewed last month (pcpro.link/alwarbird).

There aren't a huge number of upgrade options if you want to push things further, though. There's only room for a single-height card to fit into the empty PCI Express x16 slot, with one of the two uninhabited PCI Express x1 slots blocked by the graphics card.

There's much more room for storage expansion, although it will take even the most ardent video editor some time to fill the supplied 2TB hard disk. Two 5.25in bays sit empty just below the hard disk, with space for a further two 3.5in drives next to the Aerocool 600W power supply.

ABOVE There's a good reason the graphics card is at the centre: it's the heart of this PC



"And fly it did. A score of 136 is the second fastest we've seen, a single point behind Chillblast's own Fusion Centurion"

BELOW All the fans are both large and quiet, just like the Krypton Fusion itself



of the case, with a further four at the rear. Only one of the front ports and two of the rear are USB 3, which is a bit disappointing, but I was pleased to see a full-sized SD card slot and a microSD slot available. A mic and headphone socket sit there too, along with the power and reset buttons.

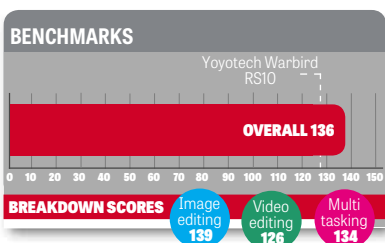
That monster graphics card offers four video outputs: two DVI-I, one HDMI and one DisplayLink. The price doesn't include a monitor to match the graphics card's skills, but Chillblast recommends the 4K, 28in AOC U2868PQU monitor (an extra £300 at time of purchase). Nor

does the price include a keyboard and mouse, but Chillblast offers Thermaltake's E-Sports Commander Gaming keyboard and mouse set as a bundle for £14.

Is the Krypton worth £916? If you're after this amount of gaming performance, yes. I totted up the prices of all the components, and once you factor in the cost of Windows and a two-year, collect-and-return warranty it's something of a steal. The biggest expense is the graphics card (around £275), so just be sure you want this much power before pressing the Buy button. **TIM DANTON**

SPECIFICATIONS

3.5GHz Intel Core i5-6600K overclocked to 4.4GHz • 16GB 2.13GHz DDR4 RAM (2 x 8GB) • MSI GeForce GTX 970 graphics card • 256GB Samsung SM951 M.2 SSD • 2TB Seagate Barracuda hard disk • Chillblast Kube microATX case • 600W Aerocool Integrator PSU • 2yr C&R warranty (parts & labour) plus 3yr RTB (labour only) • 278 x 420 x 410mm (WDH) • Windows 10 Home



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Asus C201 Chromebook

It has weak points, but the Asus C201 is ideal for life on the move thanks to incredible battery life

SCORE ★★★★★

PRICE £167 (£200 inc VAT)
from currys.co.uk

If there's one thing Asus seems to care about when making Chromebooks such as the Asus C201, it's battery life. You can almost imagine the company president slamming his fist on the boardroom table when the C200 was launched last year, demanding more from his quivering engineers: "Eleven hours from an Asus Chromebook, you pathetic layabouts? That's not good enough."

Seen through this (fictional) prism, 2015's updated model makes sense. While the Celeron inside the previous version was light on fuel consumption, the ARM-based Rockchip in this iteration is positively weightless. Asus claims a staggering 13 hours, and while my real-world tests suggest you're more likely to get 12 – with the screen's brightness set to low – that's still amazing.

Especially when you consider that this Chromebook weighs less than 1kg (980g, to be precise). Sling it into a bag and it's barely noticeable, and since you don't need to worry about carrying the power supply around with you, it couldn't score much more highly for portability.

Further good news comes if you need to give it an emergency charge: it went from empty to full in less than an hour. Bad news? Although the charging port looks like micro-USB, it isn't – you need Asus' specific charger, which supplies power at 12V and 2A.

Should you decide to take the Asus with you on your travels, it's sturdy enough to sling into a case. It's a largely plastic affair and the screen does feel vulnerable to direct hits, but little else can go wrong: there's no mechanical disk, only 16GB of eMMC flash storage. This is upgradable via a microSD slot on the left of the chassis, but Google wants you to store almost everything in the 100GB of Google Drive storage that comes included (the subscription lasts for two years).

Those who value style may feel a little self-conscious as they whip this laptop out in Starbucks when everyone around them is tapping away on their MacBooks – it certainly isn't a machine I'd take into a sales meeting – but the dark blue lid with an updated Chrome logo means it looks respectable enough. It's more smart casual than business casual.

The C201 won't embarrass you when it comes to speed, though. If you're an Intel traditionalist, you have nothing to fear from switching to ARM. I found it responsive in every situation I threw at it, from jumping around Word Online documents to viewing embedded videos on the BBC website and editing photos on Pixlr.

Naturally, as it runs Chrome OS, I couldn't run the PC Pro benchmarks, but JetStream – the natural successor to the now defunct SunSpider benchmark – returned a score of 44. That outperformed my Dell XPS 13, powered by a Core i5 processor, which scored 42. JetStream is a web-app-based benchmark, but in this case it's 100% relevant because you'll only be using web apps on the C201.

Where it falls behind more luxurious machines such as the XPS 13 – and even behind rival Chromebooks such as the Toshiba Chromebook 2 – is the screen. Its 11.6in diagonal holds 1,366 x 768 pixels and it looks sharp, but it uses cheap TN technology rather

than IPS. That means viewing angles are poor and, to my eyes, the screen also looked slightly washed out.

Normally, that would prompt howls of derision in the PC Pro office, but it's important to bear in mind both the price and the rest of the package. It's a weak point, sure, but if all you want to do is browse the web and use apps such as Google Docs, then it's

perfectly fine. Movie watchers are likely to be disappointed.

Likewise, the keyboard. It's nothing special at all, with a damp feel to each keystroke, but it's still easy to reach high typing speeds. Plus, the only shrunken keys are the cursor keys. The only mistake I found myself consistently making was hitting the power button when I was looking for Delete. There isn't, in fact, a Delete key, only Backspace.

The touchpad is a genuine plus. It's unusually large for a Chromebook and reflects the screen ratio, which I found particularly helpful when navigating between

Chrome tabs: run three fingers along it from left to right and it flicks between the open tabs. As with all Chromebooks, there's no left- or right-click button: if you want to right-click, the easiest way is to press Alt at the same time as pressing down on the bottom of the pad.

There's a huge amount of choice if you're looking to spend £200 on a laptop. Never mind Chromebooks such as the HP Chromebook 11, you should also consider the Windows-powered Toshiba Satellite C40-C and HP Stream 11.

The Asus C201 Chromebook has carved out its own niche, though, thanks to battery life and portability. Its screen isn't perfect, nor is it the most luxurious laptop, but if you want something that you can sling into a bag for a weekend and not worry about chargers, it's a great choice. **TIM DANTON**

SPECIFICATIONS

Quad-core 1.8GHz Rockchip RK3288C processor • 4GB DDR3 RAM • 11.6in 1,366 x 768 TN display • Rockchip Mali T764 GPU • 16GB eMMC • microSD slot • 802.11ac Wi-Fi • Bluetooth 4 • 2 x USB 2 • micro-HDMI • lithium-polymer battery • Chrome OS • 287 x 194 x 17.9mm (WDH) • 0.98kg • model number: C201PA-FD0009

ABOVE The C201 is a largely plastic affair and the screen feels vulnerable to bumps

“The touchpad is large for a Chromebook and reflects the screen ratio, which I found helpful when moving between Chrome tabs”

ABOVE The C201 feels more smart casual than business casual

LEFT Charging takes less than an hour via Asus' proprietary charger



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shieldx2.co.uk

Samsung Gear VR Innovator Edition for S6

Currently the best taste of VR – if you own a Galaxy S6 phone, why not give in to temptation?

SCORE ★★★★★

PRICE £141 (£169 inc VAT) from samsung.co.uk

This is Samsung's second Gear VR headset, but don't be fooled into thinking the Innovator Edition is some kind of follow-up – it's pretty much the same, only designed to fit a different handset. While the original Gear VR would only fit the Note 4, this version is designed for the Samsung Galaxy S6 and S6 Edge.

The Note 4 has a larger screen and a lower pixel density than the S6 and S6 Edge, which you'd think might make a difference. In practical terms, however, you'd struggle to tell the two apart. It remains a little blurry at times – you can see the pixels surprisingly clearly – but you stop noticing that very quickly.

Other changes? You can now charge the phone through the headset, if you're willing to be tethered via a cable to your laptop or the mains, and there's no visor covering the phone at the front, but that's about it. It's still finished in smooth white plastic and feels like a well-made piece of kit.

Unlike the Oculus Rift, the Gear VR headset is merely a shell for the Galaxy phone to fit in. All the heavy lifting is done by the phone – the Galaxy S6 or S6 Edge, in this case. Other phones won't fit and won't be detected. Once connected to the micro-USB dock in landscape mode and clipped into place, the phone chimes to let you know it's booting into VR mode.

Navigating around this brave new world of virtual reality is a breeze with

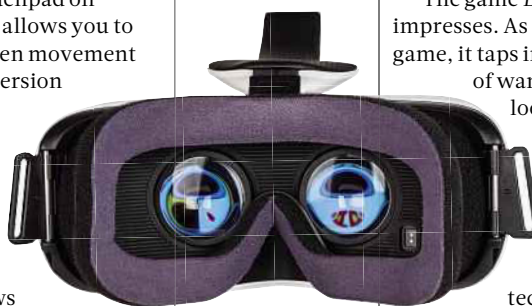
the Gear VR. The menu is presented as floating in front of you, and a tutorial instantly explains how things are done. Looking at menu items and touching the pad on the side of the headset selects them, while swiping your finger along a touchpad on the side of the headset allows you to control menus, and even movement in the virtual-reality version of *Temple Run*.

There's a back button on the side, too, which will always bring you back to the main menu should you need it, and even allows you to see out of the phone's camera, so you can tell if people are pulling faces at you in the real world.

Setting up a Bluetooth gamepad isn't controlled through the headset. This isn't required for everything, but any games beyond the superficial require titles one. Samsung sells its own game controller, but any Bluetooth pad will suffice – in theory. You can connect a PlayStation 4 pad to the Galaxy S6, but I found it was prone to strange key mapping and – worse – it occasionally got stuck and I found myself spinning on the spot. A Nexus Bluetooth pad fixed the problem and opened up a host of meaty gaming experiences.

The apps all come from the Oculus store, which is integrated with the headset. Samsung suggests you set up card details beforehand, but don't get too excited: the store remains pretty barren. There's a strange mix of glorified tech demos and existing companies trying to find their feet in the strange new world of VR (including Netflix, complete with a virtual living room in an exotic wooden

ABOVE There is no visor at the front – the Gear VR is a shell for your phone



ABOVE The image remains quite blurry at times, but you soon stop noticing

“Although the headset provides full head-tracking technology, there's no connection with the rest of your body”

cabin). The various video demos are more impressive, usually used to promote films. For example, the *Jurassic Park* scene sees a brontosaurus coming so close you have to fight the flight reflex.

The game *Dreadhalls* also impresses. As a slow-paced horror game, it taps into the paranoia of wanting to constantly look over your shoulder. The downside of the tech soon becomes apparent here, however: although the headset provides full head-tracking technology, there's no connection with the rest of your body. This means you have to adjust which way you're facing using the gamepad, which can lead to a strange disconnect between the way you're physically facing and the way you're looking in-game.

But I'm nitpicking and this is, to an extent, just the growing pains of a completely new technology. While there aren't any truly phenomenal gaming experiences available yet, the Gear VR Innovator Edition for S6 is a great taste of things to come, and it's clearly different enough to be a game-changer.

Before you buy, though, note that the Oculus Rift is set to arrive in early 2016. Still, VR is an exciting technology and the Gear VR is currently the best way to experience it. If you want to be at the cutting edge, buy one. **ALAN MARTIN**

SPECIFICATIONS

Accelerometer ● gyro sensor ● proximity sensor ● 196 x 98.5 x 82.5mm (WDH) ● 420g

BELOW The Gear VR is still finished in smooth, white plastic and feels well made



MSI GE72 2QD Apache Pro

Big, brash and powerful – a monster of a gaming laptop at a very reasonable price given the specification

SCORE ★★★★★

PRICE £874 (£1,049 inc VAT) from uk.msi.com

MSI doesn't do middle-of-the-road laptops – it makes brash, in-your-face laptops built for gaming. With the GE72 2QD Apache Pro, it delivers a 17in beast packed with powerful components at a modest price.

It's not ugly, despite its size. The base may be plastic, but the lid and keyboard surround are clad in brushed black aluminium. I can't fathom why MSI thought it wise to extend the brushed-aluminium look to the touchpad, though. In reality, it's still plastic, but lacks the smooth glide of normal touchpads. However, the fact that most keen gamers will opt for a dedicated mouse mitigates this decision.

Once you switch it on, the Apache Pro has a hallucinogenic haze of ever-changing lights that beam out from beneath the keyboard. You can switch these off but – call me crazy – I rather liked them, especially the option to create a rainbow selection.

As with most 17in gaming laptops, the GE72 is a desk hog. It measures 419 x 280 x 29mm (WDH) and weighs a hefty 2.7kg, so you aren't going to want to lug it around. Still, this is a do-it-all laptop designed to replace a hulking desktop, not a commuter's companion. It even has a DVD writer.

At the heart of it all is a fifth-generation Intel Core i7-5700HQ processor with a nominal clock speed of 2.7GHz, Turbo Boosting to 3.5GHz in times of need. Backing that up is a

respectable 8GB of RAM (expandable to 16GB), plus an Nvidia GeForce GTX 960M supplied with 2GB of GDDR5 memory. When you don't need the power of the 960M, Intel's on-chip HD Graphics 5600 GPU takes over and eases the burden on the battery. As for storage, the Apache Pro is equipped with a 128GB SSD, plus a mechanical 1TB hard disk. Windows 10 boots before you know it.

The Apache Pro aced the gaming benchmarks, too. It beat the Chillblast Helix 2 (pcpro.link/256chill) – a laptop that, on paper, should be more powerful. Running through *BioShock Infinite's* benchmarking utility, the Apache Pro hit 81fps at 720p in Ultra mode. Knock up the resolution to 1080p and the frame rate drops, but it's still playable.

While the added grunt of the Core i7-5700HQ helps MSI's laptop get ahead in the games department, the limitation of 8GB of RAM means it falls short of the Helix 2 in our general-use tests, recording an overall score of 90 compared to the Helix's 96.

Connectivity is great, especially when it comes to video. You can plug in two external monitors via the HDMI and DisplayPort outputs, and if you own two 4K monitors, you can output to both simultaneously – although don't expect smooth, full-resolution gaming if you do.

The Dynaudio-branded speakers pump out a substantial sound, but the chassis vibrates at higher volumes. Elsewhere, you have everything you'd expect from a high-end laptop: three USB 3 ports, one USB 2, dual-band

802.11ac Wi-Fi, Gigabit Ethernet, Bluetooth 4 and an SD slot.

As you can imagine, with a 17in screen and an i7 processor, the Apache Pro devours the battery. It lasted 3hrs 6mins playing a 720p video with the screen set to a brightness of 170cd/m², and you can expect half that figure when you play games.

The worst aspect of the Apache Pro, however, is its display. While it's not drastic enough to ruin games, it's not pleasing on the eye. Maximum brightness is decent at 281cd/m², and a contrast ratio of 1,222:1 ensures that images pop off the screen, but colour accuracy is poor. MSI's IPS panel gives

many colours a blue cast, although it does bundle an app that lets you tweak the display.

None of that will matter if you plug the laptop into an external display, of course, and as

soon as you boot up *Fallout 4* or run through the plains of Eorzea in *Final Fantasy XIV*, you'll stop caring about its shortcomings and remember that you've got a great gaming laptop at a bargain price. **VAUGHN HIGHFIELD**

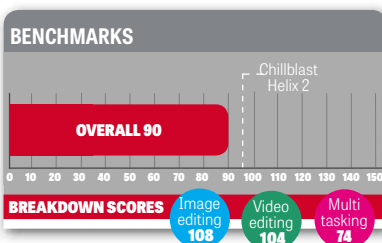
SPECIFICATIONS

Quad-core 2.7GHz (3.5GHz with Turbo Boost) Intel Core i7-5700HQ processor • 8GB RAM • 128GB SSD • 1TB hard disk • DVD writer • 17.3in 1,920 x 1,080 IPS display • Nvidia GeForce GTX 960M graphics • 802.11ac Wi-Fi • Bluetooth 4 • Windows 10 • 1yr RTB warranty • 419 x 280 x 29mm (WDH) • 2.7kg

ABOVE This 17in laptop is stylishly dressed in brushed black aluminium

"This is a do-it-all laptop designed to replace a hulking desktop, not a commuter's companion. It even has a DVD writer"

BELOW You won't go short of ports on the Apache Pro





Samsung Galaxy Tab S2 9.7in

The Tab S2 delivers quality in all the areas that matter – it's the best-value large Android tablet around

SCORE ★★★★★

PRICE 32GB black version, £228 (£274 inc VAT) from simplyelectronics.net

There are certain things that you're guaranteed to get with the 9.7in Samsung Galaxy Tab S2. The first is quality. It's clear from the moment you pick it up that this is a premium tablet, with no hint of flex and a stylish, understated design. The second is speed. Inside sits an octa-core processor and 3GB of RAM, which combine to give slick performance in pretty much everything you do. And the third is a magnificent 9.7in display.

Even more impressive is that Samsung delivers all this in a tablet only 5.6mm thick. It's easy to let a stat like that wash over you, so let me emphasise the point: it means there's barely 1mm of metal above or below the headphone socket (which sits at the bottom of the device). In a world where we've come to expect truly remarkable engineering as a matter of course, it's, well, truly remarkable.

Naturally, the S2 is light too. At 389g, it's 10% lighter than the 437g Apple iPad Air 2. Just as importantly, the Galaxy Tab S2 feels well balanced in the hand, which is rather important if you're going to watch films with it.

However, Samsung's designers need to have a rethink here. When watching video, my right hand's instinctive position meant my little finger covered one of the speakers while my thumb all too easily brushed the back button. This isn't disastrous, but it meant I had to position my hand in a certain way.

■ Design and software

I described the Tab S2 as understated, which could be seen as a backhanded compliment. Others might call the gold version a little dull and prefer the white or black versions, but it's certainly the colour I'd opt for if all prices are equal. That said, the black version tends to be significantly cheaper, as the gold version only appears to be available from a handful of retailers, such as John Lewis.

I initially liked the fact that Samsung is selling a keyboard cover to go with the S2. This cleverly clips into

the two depressible buttons fitted into the Tab's rear. However, in the UK at least, it's expensive: in the US, you can get it direct from Samsung for \$150; in the UK, you must go to a third-party retailer such as Mobile Fun, where it costs a cough-inducing £150.

This is a shame, especially when Samsung puts productivity at the forefront of the Tab S2. It preloads Microsoft Word, Excel, PowerPoint and OneNote, and that makes perfect sense with a large 4:3 screen. When paired with the right keyboard, this is a machine that you can actually do things with.

As ever, Samsung can't help but add its own TouchWiz software layer over Android 5.0.2 (Lollipop), but the end result is easy to get to grips with. I still prefer vanilla Android, but TouchWiz isn't overly invasive.

■ Screen quality

I've already nailed my feelings to the mast regarding the Tab S2's screen: it's one of the best out there. Let me qualify that to an extent, though, as in its default setting (Adaptive display), some might find its vibrant colours a little too eye-popping. Naturalists will prefer the Basic mode, but, to my eyes, it turns everything a little drab.

That said, to get the best accuracy, you should switch to Basic. In this mode, it covered 100% of the Adobe sRGB gamut in our tests, and as it uses Super AMOLED technology, contrast is perfect. Naturally, it's darned crisp too: that's what happens when you pack 2,048 x 1,536 pixels into a 9.7in screen. That resolution translates into 264ppi – exactly the same as the iPad Air 2.

■ Performance

The internals of the Samsung Galaxy Tab S2 9.7in are identical to its 8in sibling, the cunningly titled Samsung

ABOVE The display is one of the best out available

"In a world where we've come to expect truly remarkable engineering as a matter of course, it's, well, truly remarkable"

Galaxy Tab S2 8in, so it should be no surprise that the two perform almost identically in benchmarks.

For example, it scored 1,268 in the single-core Geekbench 3 test and 4,295 in the multi-core test – within a percent or two of its brother. While that put the Tab S2 8in in the upper echelons of compact tablets, it's a more mixed result in relation to larger rivals. The iPad Air 2 scored 1,683 (33% faster) and 4,078 (5% slower), for example.

Its gaming benchmark scores were less impressive. I put it through its paces in GFXBench 3.1 and found it stumbled compared to the best tablets, typically rendering half the frames per second of the iPad Air 2 or the Nexus 9.

But, frankly, you can get lost in benchmarks. What really matters is that this is a fast performer in all the areas that matter. It's still more than capable of handling demanding games such as *Hearthstone*, and should power through web browsing, most games and whatever else you throw at it for years to come.

■ Battery life

I was, at first, a little fearful to see that Samsung had opted for a 5,870mAh battery, significantly smaller than the Apple iPad Air 2's 7,340mAh. In practice, though, it delivers: it lasted 12hrs 9mins in our video-rundown test, an hour and a half longer than the iPad Air 2. (Note: we've changed the brightness that the battery test is run at, so results in other reviews may

BATTERY: video playback, 12hrs 9mins



not be directly comparable – however, we did retest the iPad Air 2.)

This is credit to the efficiency of the processor, which will switch to the lower-power 1.3GHz cores when it can afford to. If you're playing games, then expect much worse stamina. Likewise, pumping the screen up to its full 359cd/m² brightness will drag life down.

I was also pleased to see little drop-off overnight. Traditionally a strength of iPads, the Tab S2 9.7in lasted a full week of light use between charges, with less than 1% lost while I was sleeping each night.

Value for money

Samsung initially suggested that the 32GB version of the Tab S2 9.7in was going to sell for £399, the same as the iPad Air 2, so it's interesting to see that the price has already dropped to below £280 in a number of shops. At the same time, we're seeing the Nexus 9 drop to sub-£200 levels.

However, I'd still say the 9.7in has the edge on value for money. It feels and looks significantly superior, there's 32GB of storage to the Nexus 9's 16GB, and the screen is that much bigger and better. If you can buy the Tab S2 9.7in for less than £280 (as we could at the time of going to press, but prices do bounce around), the word bargain creeps to mind.

That's especially true when you consider you can add up to 128GB of additional storage via the microSD slot, so opting for the 32GB model now won't be a decision you later regret.

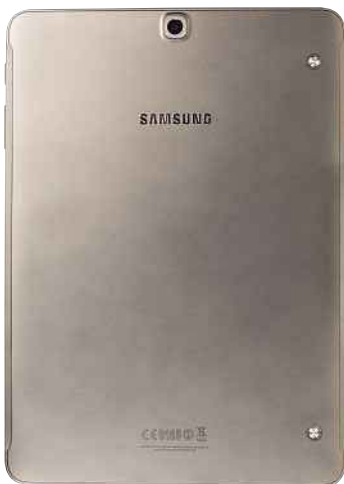
Verdict

The Tab S2 9.7in isn't a perfect tablet: gaming performance could be better, while a lack of accessories compared to the iPad 2 Air holds it back. Come on Samsung UK, make that keyboard cheaper!

However, Samsung hasn't compromised in the areas that matter. As I did right at the start, I'll come back to that screen and the build quality. Factor in the price, and the Galaxy Tab S2 9.7in becomes PC Pro's top choice for larger Android tablets. **TIM DANTON**

SPECIFICATIONS

Octa-core 1.9GHz/1.3GHz Samsung Exynos Octa 5433 processor • 3GB RAM • 32GB storage • microSD slot • 9.7in 2,048 x 1,536 Super AMOLED display • 2.1MP/8MP front/rear cameras • dual-band 802.11ac Wi-Fi • Bluetooth 4.1 • 5,870mAh Li-ion battery • Android 5.0.2 • 1yr RTB warranty • 169 x 5.6 x 237mm (WDH) • 389g



“You can add up to 128GB of additional storage via the microSD slot, so opting for the 32GB model won't be a decision you later regret”

BELOW The S2 has a stylish, understated design without a hint of flex

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Motorola Moto 360 (2015)

A much better smartwatch than last year's Moto 360, with a longer battery life and more elegant design

SCORE ★★★★★

PRICE £191 (£229 inc VAT)
from motorola.co.uk

As updates go, there can't have been one as sorely needed as this. The first Motorola Moto 360 was among the most attractive smartwatches on the market, but it suffered from poor battery life and sluggish performance.

The second-gen Moto 360 fixes both those problems by replacing the ageing 45nm Ti OMAP 3 processor of the original with a 1.2GHz quad-core Qualcomm Snapdragon 400. It's a more efficient unit and that shows in the watch's stamina. Even though the new watch is smaller and has a low-capacity 300mAh battery, it comfortably made it to the end of every day of my tests, with room to spare.

With the screen set to off, except for when I raised my wrist to check notifications, it lasted a solid two days, and the larger 46mm Moto 360 ought to deliver even better stamina thanks to its 400mAh battery.

Nor is the Moto 360 Collection, as Motorola dubs its watch offering, restricted to just these two watch sizes. There's a "designed for women" model with a 42mm housing and a narrower 16mm wristband, plus a fitness-focused model – the Moto 360 Sport – that has an embedded GPS so you can track your runs without having your phone, and a silicone rubber housing and strap.

Significantly, Motorola has gone big on customisation, too. Buy a Moto 360 via the Moto Maker website and you'll be able to set the size and strap type, the colour of the watch body and bezel independently from one another, and even add a "micro knurl" texture to the front bezel for extra bling.

Motorola claims there are more than 300 possible combinations and, unlike the Apple Watch, going for a metal strap won't leave you bankrupt: choosing stainless steel only adds £30 to the price. Better still, changing straps is now easier than before. Motorola has added a small quick-release tab to the straps' spring bars



(the bits that attach the strap to the watch body), which allow you to chop and change as the mood takes you.

I was sent the smallest model, complete with slim strap and the smaller 42mm body, and apart from the disturbing flesh-tone leather wristband, I rather liked it. The smaller housing is the perfect size for my relatively slim wrists, and I suspect that it will be for many people, male or female. Motorola has got its design spot on this time.

Elsewhere, there are few changes from last year's model. The watch still has a PPG heart-rate monitor and can't do continuous monitoring. Instead, it's set up to carry out spot checks throughout the day and report back via the watch's accompanying Moto Body Heart Activity app.

The 360 sticks with a backlit IPS panel rather than an AMOLED, but there's nothing wrong with its brightness levels, colours or sharpness. It's topped with Gorilla Glass 3, which remained pristine on my review sample, and the whole shebang is weatherproofed to the IP67 standard.

Motorola has also kept the light sensor in place, which impinges on the watch's elegant lines. Embedded in a small black segment at the bottom of the watch face, this ensures you don't have to adjust the brightness manually.

Note that the resolution and

pixel density of the screen varies depending on the model you choose. The smaller 42mm watch has a slightly sharper display (at 360 x 325 and 263ppi) than the 46mm model (at 360 x 330 and 233ppi), but that's not a huge difference and you'll struggle to tell the difference between the two at normal viewing distances.

The 360 also retains that most useful of smartwatch features: inductive wireless charging. It supports the Qi standard, so not only can you charge the watch on the bundled cradle, but also any other wireless-charging plate that supports the same standard. You can even use one of Ikea's wireless-charging bedside tables.

As for software, you still get the Motorola Moto Body apps, which record your heart rate, steps and calories, plus there's an expanded selection of Motorola watch faces, with three new ones added this time around. And, of course, it all runs on Android Wear, which continues to improve and mature.

Android Wear's Google Now-based, voice-driven UI suits the smartwatch concept, with only one niggle: Google hasn't nailed the way apps present and bundle together notifications. While the Google apps work perfectly, presenting lists of

individual notifications that can be expanded and read in full at a tap, the experience becomes inconsistent once you step outside those boundaries to third-party apps.

Slack and Outlook, two apps I use heavily every day, are examples of this, bundling up multiple notifications into hard-to-read lists on single notification cards that can't be expanded or read fully.

Still, there isn't much that Motorola can do about that, and what it has done with the Moto 360's hardware is to be applauded. The second-gen Moto 360 is a much more attractive, refined and practical smartwatch than last year's model. The Huawei Watch (opposite) wins out for its AMOLED display and styling, but the Moto 2 is an excellent and highly customisable alternative. **JONATHAN BRAY**

ABOVE The Moto 360 sticks with a backlit IPS panel, instead of an AMOLED display

"Buy via the Moto Maker website and you'll be able to set the size, strap type and the colour of the watch body and bezel"

BELOW The smaller housing is the perfect size for those with relatively slim wrists



SPECIFICATIONS

Quad-core 1.2GHz Qualcomm Snapdragon 400 processor • 512MB RAM • 4GB storage • 1.37in 360 x 325 IPS display • Bluetooth 4 • 802.11g Wi-Fi • 300mAh battery • PPG heart-rate monitor • accelerometer • gyroscope • Android Wear OS • 1yr RTB warranty • 42 x 11.4 x 42mm (WDH)

Huawei Watch

It's attractive, packed with features and the best Android Wear watch you can buy

SCORE ★★★★★

PRICE £241 (£289 inc VAT)
from huawei.com/uk

Let me beat around no bushes: this is the best Android Watch around, bar none. What lifts it above the rest isn't some major breakthrough – battery life, speed, an ultra-sleek design – but a collection of little details that edge it above the competition.

Take its looks. Compared to other Android smartwatches, the Huawei Watch has a slimmer bezel, thinner body and – the aspect so difficult to translate into specs and comparatives – it exudes style and sophistication.

Just like rivals such as the Apple Watch and the second-gen Motorola Moto 360 (see opposite), the Huawei Watch is available in a number of different “styles”. These range in price from a base of £289 inc VAT for the Classic with a standard black leather strap, up to £389 for the Active version with a black-plated stainless steel link strap. There's even a rose-gold version of the watch.

There's no technical difference between the Active and Classic versions, colour aside, and whichever one you go for, it looks wonderful. I was sent the basic Classic with black leather strap, but even this cheapest version looks stunning, and what's more, it's extremely comfortable to wear.

It's the display that steals the show here, however. It measures 1.4in across and, with a 400 x 400 resolution, delivers the highest pixel density (at 286ppi) you'll see on any smartwatch. Most other Android devices have 320 x 320 screens.

Practically speaking, the difference isn't huge, but it is possible to tell the difference if you look closely, and it's the details that count. It's only a shame so many of Huawei's 40 preloaded watch faces fail to take full advantage of this glorious screen, and are either cheesy or obviously computer-generated.

Still, the screen's a boon for watch-face addicts and anyone who likes to create



their own faces via apps such as WatchMaker and Facer. And since the technology used in the screen is AMOLED, it makes a big impact, with inky black and vibrant colours the order of the day.

It will look good for a long time to come, too. The super-tough sapphire crystal glass screen is more often found on boutique, high-end Swiss watches costing many more times the price.

Inside, things are considerably less exciting. A 1.2GHz Snapdragon 400 provides the power, just like almost every other Android Wear device currently on sale. Then there's an equally predictable 512MB of RAM and 4GB of storage.

It connects to your phone via Bluetooth 4, has a heart-rate monitor and six-axis motion sensor for fitness tracking, while charging is taken care of by a magnetic, clip-on puck. This gets the watch from zero to 100% in just over an hour. There's also a barometer, which is used by the

Huawei activity-tracking app to gauge how many stairs you've walked up and down in a day.

ABOVE A super-bright AMOLED display separates the Huawei Watch from its rivals



“The super-tough sapphire crystal glass screen is more often found on boutique, high-end Swiss watches at many times the price”

BELOW The watch charges via this magnetic puck, going from zero to full in just over an hour



When it comes to responsiveness, it's smooth most of the time, with the odd stutter and hiccup. It's no different to any other Android Wear device in this respect, and the stutters certainly don't get in the way of usability.

Battery life is surprisingly good. Despite a comparatively small 300mAh power pack – the same as the smaller Moto 360 opposite – it lasted almost two days, with the Always-on screen option activated and the brightness set to maximum during the day and minimum during the evening. I still found myself charging the watch most nights, just for peace of mind, but it will get you through two working days if you forget.

As for software, it sports the latest version of Android Wear, and this works as well as it does on any other Google-based smartwatch (for a full review of Android Wear, visit pcpro.link/256wear). The only difference here is that Huawei supplements the standard install with its own set of watch faces, plus a set of apps for fitness, activity tracking and heart-rate monitoring. These look very attractive, but the only out of the ordinary feature compared to other Android watches is Huawei's stair-tracking function.

The one thing that might give you cause for concern is the price. The Huawei Watch is more expensive than any other Android Wear smartwatch. It's pricier than the second-gen Moto 360 and LG Watch Urbane, and its base model is only £10 cheaper than the equivalent Apple Watch. At least the premium models aren't as expensive as Apple's finest.

If you have an iPhone, the best smartwatch to own remains the Apple Watch. It does everything and more than the Huawei Watch, and isn't much more expensive (at least, the cheapest Sport model isn't).

If your predilection is for an Android smartphone, on the other hand, this is the best you can buy now. From its crisp, vibrant AMOLED display to its sapphire crystal glass top, and its slimline body to its high-end looks, it nails every aspect of the formula. **JONATHAN BRAY**

SPECIFICATIONS

Quad-core 1.2GHz Qualcomm Snapdragon 400 processor • 512MB RAM • 4GB storage • 1.4in 400 x 400 AMOLED display • Bluetooth 4.1 • 300mAh battery • PPG heart-rate monitor • accelerometer • gyroscope • Android Wear OS • 1yr RTB warranty • 42 x 11.3 x 42mm (WDH)



Mobile apps

Magpie

SCORE ★★★★★

PRICE £3.99



Apps that save web pages for later reading are common. There's Instapaper and Pocket, both of which are cross-platform. And there are also built-in versions, such as the Reading List apps in Windows 10, iOS and OS X. But there isn't anything that does a similar job just for video.

That's where Magpie comes in. It works on iOS (both iPhone and iPad are supported) and OS X, and it has a tvOS app so it'll also work on the latest Apple TV. Whenever you're watching a video in Safari (or any other app that supports the Share menu), you can use the Extensions menu to save it to Magpie. If it's hosted on YouTube or Vimeo, you can watch it in

Magpie's native player, which does smart things such as preserving the place you've got to in a video across platforms. If the video isn't hosted on either of these platforms, it saves a bookmark to the whole web page, meaning that you can revisit the page later.

What it doesn't do is save the video for offline viewing, so don't expect to be able to pack your Wi-Fi-only iPad with YouTube videos to keep the kids amused on a long car journey. This makes it much less like Instapaper or Pocket, both of which save text articles for reading offline. It's also worth noting that the OS X application will cost you additional

money, so if you want to save from the Mac for later viewing on your iOS device, you'll have to invest more. There's also no free bookmarklet to let you save just from Safari.

In use, Magpie works exactly as promised. It's certainly nice to start watching a video on the iPad and then move to Apple TV, picking it up at the exact same point.

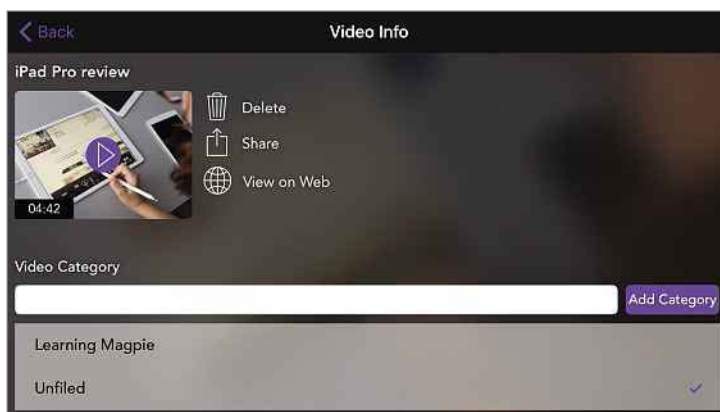
However, because Apple has chosen not to build browsing capabilities into Apple TV, this only works for YouTube and Vimeo videos.

At present, Magpie is a promising application that's not quite a must-have for your devices, unless you watch a lot of YouTube videos and like to be able to bounce between platforms. It would be good to see the list of video providers that the player supports increased, and if Magpie could also offer offline viewing by caching the video locally, it would be a highly recommended product. At the moment, though, Magpie is useful for a handful of people, but probably not a product most users should invest in.

IAN BETTERIDGE

"It's certainly nice to start watching a video on the iPad and then move to Apple TV, picking it up at the exact same point"

BELOW If the video is hosted on YouTube or Vimeo, you can watch it on Magpie's player



DSCO

SCORE ★★★★★

PRICE Free



This app from VSCO lets you make GIFs, add simple filters and share via VSCO and your social network of choice. Point the camera, hold down the screen and you'll record a looping clip of up to 2.5 seconds. After you've published, the GIF will be saved on your camera roll both as a GIF and an MP4 video.

In practice, it works a bit like a cross between Vine and Snapchat – with a simple user interface that lets you hit the ground running. The app's minimalist design can sometimes be confusing, but there's something charming about jittery GIFs that keeps them popular on the internet, and this app is a useful tool for making your own. **THOMAS MCMULLAN**



ABOVE This simple app is a great of making, somewhat jittery, GIFs

TunnelBear VPN

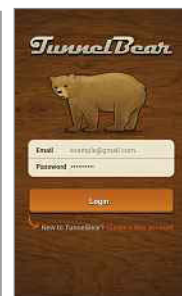
SCORE ★★★★★

PRICE Free for 500MB/mth; unlimited, £4.99/mth



Some VPN apps can be confusing. Very confusing. Some VPN apps can be buggy. Very buggy. Well, luckily this one is simple to understand and it works well. Very well. Bravo, TunnelBear.

TunnelBear VPN comes with a free tier that grants you access 500MB of data per month. That means you can download and watch the equivalent of an hour's worth of BBC iPlayer video on your Android device before your credit runs out. Luckily, the paid version of the app isn't too steep: unlimited use for any five computer, smartphone or tablet devices will cost you a reasonable £4.99 per month. **DAVID COURT**



ABOVE TunnelBear VPN is very easy to understand and works well



1Writer

SCORE ★★★★★

PRICE £3.99



Markdown text editors are scattered across the App Store, but editors that work well with iOS 9, iPad, iPhone and iPad Pro are much rarer beasts. 1Writer is currently probably the only one – and, thankfully, it's also exceedingly good.

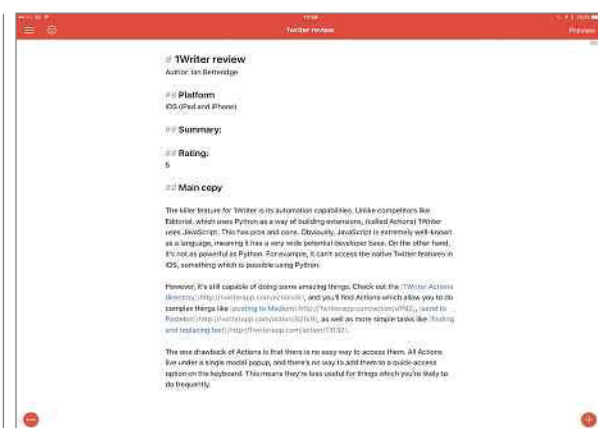
1Writer has many similar features to competitors such as Byword and Ulysses. There's a keyboard with an additional layer of buttons that let you drop in links, bullet points and images. Images are automatically uploaded to Dropbox, CloudApp or Dropplr, and files are synced to

Dropbox or iCloud. You can even choose to have different folders of documents on different services, if you prefer.

There's a one-tap preview mode, which displays your fully formatted document, while a swipe to the left brings up a built-in web browser, so you don't have to use iOS 9's split-screen view.

Twitter addicts will appreciate the option to include hashtags in docs. The file browser will list all the hashtags used across your documents, letting you jump to any document including that term. You can create to-dos within a document and export all of them to Reminders, which is incredibly useful for anyone taking notes in a meeting.

The killer feature for 1Writer is its automation capabilities. Unlike competitors such as Editorial, which uses Python as a way of building



ABOVE The 1Writer app makes it easy to automate tasks such as posting to Medium



LEFT The keyboard allows you to drop in links, bullet points, hashtags and pictures

extensions, 1Writer uses JavaScript. This has pros and cons. Obviously, JavaScript is extremely well known, with a broad developer base. On the other hand, it's not as powerful as Python. For example, it can't access the native Twitter features in iOS, which is possible with Python.

That said, it's still capable of doing amazing things. Check out the 1Writer Actions directory and you'll find Actions that automate complex tasks such as posting to Medium, sending to Pastebin, as well as simpler stuff such as finding and replacing text.

The drawback of Actions is that there's no easy way to access them. All Actions live under a single modal pop-up, and you can't add them to a quick-access option on the keyboard. This means they're less useful for jobs you're likely to perform frequently.

1Writer is a well-thought-out and powerful text editor, which will only get more powerful as users expand its capabilities with Actions. It's not perfect, but if you want a text editor that makes the most of iOS 9, it's your best choice. **IAN BETTERIDGE**

The Pickle Index

SCORE ★★★★★

PRICE £3.99



Equal parts pickle-based cookbook and absurd interactive novel, The Pickle Index is a strange, mysterious tale of a circus troupe on a journey to rescue its imprisoned ringleader. Each day you'll be encouraged to amp up your "Citizenship Quotient" by reading and uploading pickle-based recipes, and, in doing so, you'll stumble through a memorable tale of fermentation and totalitarian regimes.

The Pickle Index is not an ebook, it's not a game and it's not a social network, but it takes strands from all of the above and weaves them into an unforgettable oddball caper. **THOMAS MCMULLAN**



ABOVE The Pickle Index covers both recipes and tales of totalitarian regimes



Google Translate

SCORE ★★★★★

PRICE Free



Chances are that you won't be able to learn every word of every foreign language when you travel, and that's where Google Translate comes in. At first, this may seem overkill – everyone knows you can get stiff and stilted direct translations online, so why the need for an app?

Simply because the Google Translate app throws in a bit of magic to the mix: point the camera at text, and you'll get the translation right there in front of you on your screen, with no need for fiddly typing and inevitable typos. Sure, the translations aren't flawless, but it's enough to tell if the dish you're about to order will trigger your seafood allergy. **ALAN MARTIN**



ABOVE The app's translations aren't flawless, but are good enough for basic tasks



DITCH YOUR ISP'S ROUTER

BT, Sky, TalkTalk and Virgin routers vs the rest

You don't have to put up with slow Wi-Fi and a lack of features from your ISP-supplied router. We test eight that can do a better job



With fibre broadband finally becoming mainstream in the UK, and cable reaching more customers than ever, there's a huge amount of choice when it comes to picking a broadband supplier. However, the equipment supplied by your ISP isn't always able to give you the best wireless speeds, or even a stable connection throughout your home or office.

ISPs typically stick with the same bundled routers for years at a time, so they're quickly surpassed by third-party models from other manufacturers. This is particularly true of wireless speeds: the 802.11ac market has matured rapidly in the past year, moving from AC1300 – 400Mbps/sec on 2.4GHz and 867Mbps/sec on 5GHz – to AC1900, AC2350 or even AC3200, which promises 600Mbps/sec on 2.4GHz and 2,600Mbps/sec on 5GHz. If you're still using the router supplied by your ISP, you could be seriously limiting your maximum wireless performance.

Signal strength also varies wildly between routers, with most ISP-supplied models lacking external antennae: replacing it could eliminate Wi-Fi dead spots and extend the range of your wireless network, without you having to install powerline adapters or wireless extenders.

Finally, your ISP-supplied router is most likely a barebones device, without many extra features. With the right model, your replacement router could also double as a basic NAS drive, printer server or multimedia hub for streaming video content to a smart TV or PC.

It's not just a case of swapping one box for another, though: how you upgrade will depend on your ISP and what equipment you're currently using. This Labs focuses on the four major UK ISPs and explains how to make the switch from the basic supplied router to a more capable model.

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	BT Home Hub 5	Sky Hub 2	TalkTalk HG635 Super Router	Virgin Super Hub 2ac	Asus RT-AC3200	D-Link DIR-890L
Overall	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★
Purchase information						
Price (inc VAT)	Free with broadband	Free with broadband	Free with broadband	Free with broadband	£171 (£230)	£208 (£250)
Supplier	bt.com/broadband	sky.com/broadband	talktalk.co.uk	virginmedia.com	currys.co.uk	dabs.com
Dimensions (WDH)	236 x 31 x 116mm	53 x 141 x 140mm	184 x 55 x 147mm	69 x 195 x 215mm	290 x 188 x 58mm	373 x 241 x 157mm
Service & support						
Warranty ¹	1yr RTB	1yr RTB	1yr RTB	Lifetime	2yr RTB	2yr RTB
Manufacturer reliability/overall score ²	75% / 77%	N/A	N/A	76% / 79%	86% / 87%	N/A
Core specifications						
Main internet connection type	ASDL2+; VDSL	ASDL2+; VDSL	ASDL2+; VDSL	Cable	Router only	Router only
Concurrent dual-band	✓	N/A	✓	✓	✓	✓
Maximum rated link speed, 802.11ac	1,300Mbps/sec	✗	1,300Mbps/sec	1,300Mbps/sec	1,300Mbps/sec	1,300Mbps/sec
Maximum rated link speed, 802.11n	300Mbps/sec	144Mbps/sec	450Mbps/sec	300Mbps/sec	600Mbps/sec	600Mbps/sec
MIMO stream configuration, 802.11ac	3x3	N/A	3x3	3x3	3x3	3x3
MIMO stream configuration, 802.11n	3x3	2x2	3x3	2x2	3x3	3x3
LAN ports	4 x Gigabit Ethernet	4 x 10/100 Ethernet	4 x Gigabit Ethernet	4x Gigabit Ethernet	4 x Gigabit Ethernet	4 x Gigabit Ethernet
USB/eSATA ports	USB 2	✗	USB 2	✗	USB 3; USB 2	USB 3; USB 2
Beamforming	✗	✗	Universal	Universal	Universal and explicit	Universal
256-QAM on 2.4GHz	✗	✗	✓	✓	✓	✓
On-router security & parental controls						
Security types	WPA; WPA2; WPS	WPA2-PSK; WPA2-AES	WEP; WPA2-PSK	WPA2-PSK; WPA2 Enterprise	WEP; WPA2-PSK; WPA-PSK; WPA-Enterprise	WEP; WPA; WPA2; WPA-PSK; WPA2-PSK; WPS
Web content filtering	✗	✓	✓ (hidden)	✗	✓	✓
URL whitelisting	✗	✗	✗	✗	✓	✓
URL blacklisting	✗	✓	✓ (hidden)	✗	✓	✓
Schedule-restricted internet access	✗	✗	✓ (hidden)	✓	✓	✓
WPS button/router PIN	✓ / ✓	✓ / ✓	✓ / ✓	✓ / ✓	✓ / ✓	✓ / ✓
Other						
IPv6 support	✓	✗	✓	✓	✓	✓
Wireless repeater functions	✗	✗	✗	✗	✓	✗
Power switch	✓	✗	✓	✓	✓	✓
User-configurable QoS	✗	✗	✓	✗	✓	✓
Media server	✓	✓	✓	✓	✓	✓
Torrent server	✗	✗	✗	✗	✓	✗
Guest network	✗	✗	✗	✓	✓	✓
Android/iOS app	✗ / ✗	✗ / ✗	✗ / ✗	✗ / ✗	✗ / ✗	✓ / ✓
Automatic firmware updates	✓	✓	✓	✓	✗	✗

1. Parts and labour. UK mainland, unless otherwise stated. 2. Router reliability/overall rating in reader-voted PC Pro Excellence Awards 2015. Where N/A, companies didn't receive enough feedback to be rated. See issue 294, p34.

Buyer's guide: choosing a wireless router

The type of internet connection you have will dictate which replacement router is right for you. It will also dictate whether you can ditch your ISP-provided model altogether, or whether you'll have to use it side by side with the new one.

ADSL customers have the widest choice, since ADSL is the most widely supported connection among router manufacturers. As long as you have

access to your ISP login details, you should be able to swap out one box for another – cutting down on cable clutter and freeing up a power socket.

Not all third-party routers have the necessary VDSL modems for fibre broadband connections. If you buy a router that doesn't, you'll need to use your ISP-supplied modem alongside it. However, VDSL support is gradually growing, so with the right

router you'll be able to completely replace your existing kit.

Cable connections are the least supported by third-party routers, which means you'll almost certainly need to use your existing box in tandem with any new model you buy.

With the exception of the Sky Hub 2, all the routers in this Labs support 802.11ac. This is undoubtedly faster than 802.11n, but the numbers

manufacturers use to sell their compatible routers can be a little misleading. An AC1900 router doesn't actually deliver a link rate of 1,900Mbps/sec; that number is in fact the sum of the maximum rated speeds over 802.11n and 802.11ac combined.

These numbers are also related to the number of spatial streams and the channel width your devices



			LABS WINNER	RECOMMENDED		
	DrayTek Vigor 2860ac	Linksys WRT1900ACS	Netgear Nighthawk X4S	Synology RT1900ac	TP-Link Archer C2600	ZyXEL Armor Z1
	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★
	£208 (£250)	£191 (£230)	£225 (£270)	£96 (£115)	£137 (£165)	£137 (£165)
	dabs.com	amazon.co.uk	broadbandbuyer.co.uk	synology.com/uk	pcworld.co.uk	dabs.com
	165 x 241 x 44mm	121 x 75 x 26mm	285 x 185 x 50mm	206 x 160 x 66mm	264 x 198 x 37mm	297 x 201 x 71mm
	1yr RTB	1yr RTB	1yr RTB	2yr RTB	2yr RTB	2yr RTB
	91% / 90%	N/A	87% / 87%	N/A	83% / 86%	N/A
	ASDL2+; VDSL	Router only	ADSL2+; VDSL	Router only	ADSL2+	ADSL2+
	✓	✓	✓	✓	✓	✓
	1,300Mbps/sec	1,300Mbps/sec	1,733Mbps/sec	1,300Mbps/sec	1,733Mbps/sec	1,733Mbps/sec
	600Mbps/sec	600Mbps/sec	800Mbps/sec	600Mbps/sec	800Mbps/sec	600Mbps/sec
	3x3	3x3	4x4	3x3	4x4	4x4
	3x3	3x3	3x3	3x3	3x3	3x3
	6 x Gigabit Ethernet	4 x Gigabit Ethernet	4 x Gigabit Ethernet	4 x Gigabit Ethernet	4 x Gigabit Ethernet	4 x Gigabit Ethernet
	2 x USB 2	USB 3; USB 2; eSATA	2 x USB 3; eSATA	USB 3; SD card reader	2 x USB 3	2 x USB 3
	✗	✓	✓	✓	✓	✓
	✗	✓	✓	✓	✓	✓
	WEP; WPA2-PSK	WEP; WPA2 Personal; WPA2 Enterprise	WPA/WPA2-PSK	WEP; WPA/WPA2; WPA/WPA2-Enterprise	WEP; WPA/WPA2; WPA/WPA2-Enterprise	WEP; WPA/WPA2; WPA/WPA2-Enterprise
	✓	✗	✓	✓	✓	✓
	✓	✗	✓	✓	✓	✓
	✓	✓	✓	✓	✓	✓
	✓	✓	✓	✓	✓	✓
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	✗	✗	✗	✓	✗	✗
	✓	✓	✓	✓	✓	✓
	✗ / ✗	✓ / ✓	✓ / ✓	✓ / ✓	✓ / ✓	✓ / ✓
	✗	✗	✗	✗	✗	✗

are capable of transmitting and receiving. A 1x1 configuration means one antenna supporting one data stream; 2x2 is two antennas supporting two data streams. You can guess 3x3 and 4x4.

In practice, a laptop with a 2x2 setup would only be able to connect to an AC1900 connection at 867Mbps/sec – you'd need a 3x3-stream device to get the full

1,300Mbps/sec. Support for multiple antennae and data streams is known as multiple-input, multiple-output technology and given the shorthand MIMO.

Even in ideal circumstances, you won't see file-transfer rates reach your router's theoretical maximum Wi-Fi speeds, thanks to network protocols, bottlenecks and other overheads. However, with the right

kit, you should be able to approach performance similar to that of a wired Gigabit Ethernet connection. It's worth noting that using multiple devices at the same time will split the available bandwidth, unless you use a Wave 2 router with Multi-User MIMO (MU-MIMO).

Remember, also, that upgrading your router won't guarantee the fastest possible wireless speeds:

you'll also need to invest in additional network kit for your PC or laptop if they don't support 802.11ac.

That said, even if you don't own compatible kit, an 802.11ac router can still improve the reliability of your 802.11n network. Implicit or universal beamforming can eliminate dead spots and speed up your connection in areas that were previously slow.



BT Home Hub 5

Excellent 802.11ac speeds, but the Home Hub 5 lacks features

SCORE ★★★★★

PRICE Free from bt.com/broadband

BT's Home Hub is now in its fifth iteration – and finally delivering the kind of spec we'd expect from the UK's leading ISP: not only 1,300Mbps/sec over 802.11ac, but a 3x3 internal antenna setup.

It's supplied free with new BT Infinity and Plusnet fibre broadband packages, but is also available for existing customers to buy separately through BT's online store.

With both a WAN port, for use with an external modem, and a DSL/VDSL port for a direct fibre or ADSL2+ connection, the Home Hub 5 is well suited to multiple connection types. With no way to put it into a pure modem mode, though, you can't pair it with a third-party router. In fact, whenever the Home Hub detects it's not connected to the internet, every new wired and wireless device you connect to it will be presented with a pop-up troubleshooting screen.

We expect the four Gigabit Ethernet ports included here, but a USB port is not guaranteed in an ISP-supplied router. Sadly, it's not very flexible: it refuses to recognise FAT16-partitioned flash drives, for example. The controller is restricted to USB 2 speeds, too, which made file transfers crawl to a meagre 4.9MB/sec – the slowest result in this month's



Labs. There's also no way to assign access permissions, meaning anyone on the network will be able to open files on a connected flash drive. You can at least share a printer over the network by plugging it into the USB port.

The WPS and reset buttons are within easy reach on the top of the router, and it's fairly compact, with no external antennae. The inevitable downside of this is there's no way to fine-tune the spread of your network.

By default, the 2.4GHz and 5GHz wireless bands share the same SSID, which can make it difficult to work out to which frequency your devices are connected. It also causes problems with certain media streamers and Internet of Things equipment. Thankfully, the two can be easily

separated through BT's spartan web interface.

Aside from changing wireless settings, enabling dynamic DNS and altering basic port-forwarding settings, not much is available for tweaking. There are no user-configurable QoS settings, for example. BT provides network-level parental controls for those who want them, but the router itself is restricted to device-specific scheduling.

There are some positives to the Home Hub 5, however.

BT's Smart Wireless function switches wireless channels automatically when it detects interference. This is fairly common among ISP-supplied routers, but it does an excellent job, ensuring 802.11ac wireless speeds remain high when lots of other wireless devices are present in a room.

In fact, performance in general was impressive for an ISP-supplied model. Up close, we saw file-transfer speeds reach 67.5MB/sec over 802.11ac using a 3x3 stream Wi-Fi adapter. This dropped to 17.3MB/sec on a 2x2 stream 802.11n device, but that matches both Virgin's Super Hub 2ac and the TalkTalk Super Router.

ABOVE BT's Home Hub 5 is one of the best ISP-supplied routers

Get the most from your Home Hub 5

If you decide to stick with the Home Hub 5, there are ways to make it less frustrating to use. All of the tips mentioned here use the web interface, which is available on <http://192.168.1.254> by default. You'll need to enter a password to change any settings; unless you've changed it, you'll find the password written on a pull-out card on the back of the router.

Smart Setup is the primary source of irritation. The interface that appears every time you connect a new wireless device to the router is largely useless and can stop certain devices from connecting to the internet. Go to Advanced Settings | Home Network | Smart Setup, then change Enable Smart Setup to No and click Apply, to make it disappear for good.

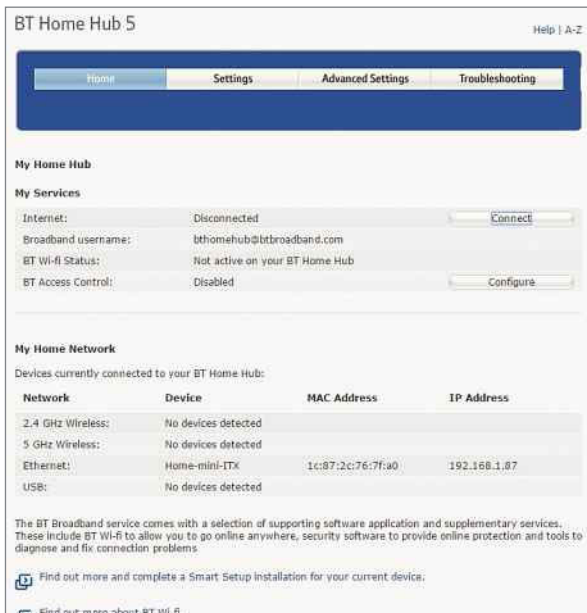
The Home Hub defaults to a single, unified, wireless SSID, which causes problems with devices such as Google's Chromecast. Giving each band its own SSID is simple: click Advanced Settings, then 5GHz Wireless, and tick No on the option that says "Sync with 2.4GHz". Lastly, rename the 5GHz SSID in the field below.

Not every ISP-supplied router has a USB port, but the Home Hub does. Plug a flash drive into it and it will automatically be shared across your network. If it doesn't appear, type `\\192.168.1.254` into a Windows Run command, or `smb://192.168.1.254` into an Apple Finder window, using the Apple+K keyboard shortcut. You'll need to eject the disk safely when you



want to remove it; go to Advanced Settings | Home Network | Devices, click the link that mentions your USB stick and click Safely Disconnect.

Finally, while you can't completely switch off the activity LEDs if you find them distracting, you can lower the brightness. Go to Settings | Hub Lights, change the brightness to Low and click Apply.



The Home Hub 5 is also capable at long range, albeit not at the same level as most third-party models. File transfer speeds fell to 25.3MB/sec over 802.11ac, and to 10.5MB/sec on 5GHz 802.11n using a 2x2-stream iPad mini.

If you don't have any 802.11ac hardware, however, the Home Hub 5 isn't such a great performer. Even with a 3x3 stream adapter installed in our PC, at close range it could only manage 7.7MB/sec file transfers, although a 2x2-stream iPad mini fared better on the 2.4GHz frequency band, transferring at 11.8MB/sec.

Things were worse over long range. Speeds of 2.6MB/sec on the 2.4GHz band were the worst of all the routers in this month's Labs.

In spite of this setback, the Home Hub 5 still offers impressive 802.11ac performance for an ISP-supplied router. As such, there are only really two reasons to consider replacing it: to improve the range for 2.4GHz devices or to gain extra features.

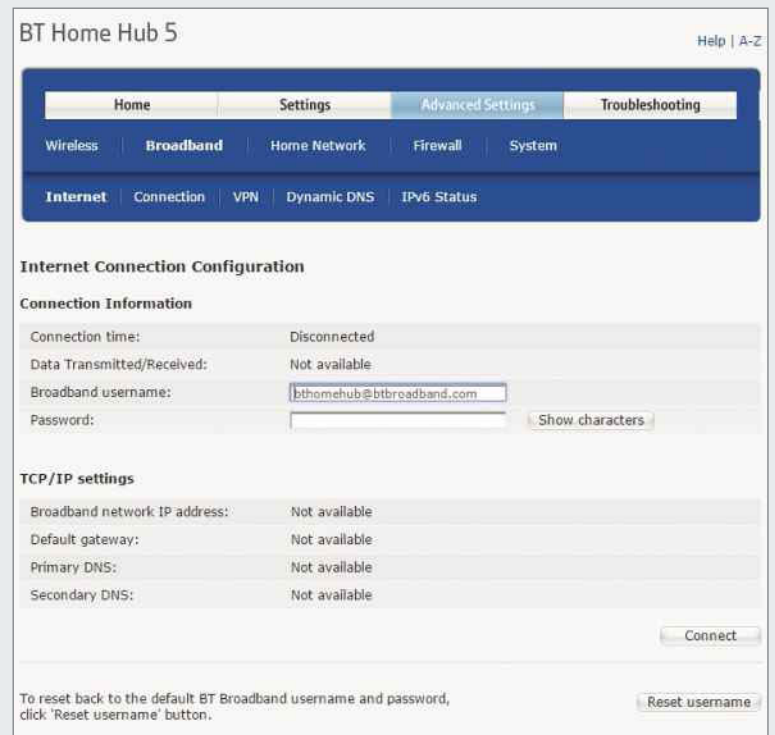
If you have an older Home Hub with a separate Openreach modem, upgrading to this model would give you a large speed boost and cut down on cable clutter next to your telephone socket. At £130, it's cheaper than many of the third-party models on test this month, and the setup process is easier for BT customers if they stick to BT hardware.

ABOVE Only basic settings can be tweaked using the web interface

BELOW Four Gigabit Ethernet ports is standard; a USB port is less common for an ISP-supported router



How to switch to another router



Switching out a BT Home Hub for a third-party VDSL router isn't as difficult as it can be with other ISP-provided routers, but if you aren't careful you'll cut access to certain BT TV channels. Make sure that any replacement router supports IPv6 multicast streams: without this feature, you might find BT Sport no longer works on your TV set-top box.

Once you've found a suitable router, however, swapping it out is as easy as recording your BT username and password, which can be found via the Home Hub 5's web interface. Type **http://192.168.1.254** into your browser and click Advanced Settings. Enter the password, which can be found on the card slotted into the back of the router (unless you've changed it), and click Broadband. Your broadband username should be displayed in the first box, with your password below it; to reveal it, click "Show characters". Write down both, then disconnect your Home Hub and wire up its replacement.

With the new router switched on, enter its web interface and look for the WAN settings page. If it asks for a connection type, set it to PPPoE, then enter your BT username and passwords in the relevant boxes. You may also need to set your VLAN ID manually; for BT Infinity it should be 101. Click Save/Apply, then reboot your router. When it comes back online, you should be connected to the internet.

You'll then need to make sure IPv6 multicast is enabled, as this isn't switched on by default on all routers. Typically, this can be found under Advanced Network Settings and is usually a checkbox. Make sure it's ticked, hit Apply and reboot your router. You should then be able to access IPTV channels again.





Sky Hub 2

Lack of 802.11ac support makes the Hub the least attractive of the ISP-supplied routers

SCORE ★★☆☆☆

PRICE Free from sky.com/broadband

If there's one area where Sky's Hub 2 scores highly, it's convenience. It supports VDSL and ADSL connections and, thanks to an integrated modem, you won't need a second box plugged into the master phone socket. It's also one of the only ISP-supplied routers with an internal power supply; the mains cable might only be a metre long, but it ends in a standard "figure of 8" connector, so it can easily be swapped out for a longer one.

The Hub 2's best feature is arguably its ability to configure to your Openreach VDSL connection when you first set it up, saving you the hassle of arranging a visit from an Openreach engineer just to switch you on at the nearest fibre cabinet. Other ISPs charge for this service, so it could also work out cheaper than opting for a different supplier. When you plug the Hub 2 in, an additional LED on the front of the unit indicates whether your Sky set-top box is connected to the internet – no extra diagnostics are required.

The Hub 2 also has an intelligent power-saving mode, automatically switching to a low-power state when no wired or wireless devices are actively using the connection. Typical power draw with the connection in use was around 5W, but this fell to



3.5W with the power-saving mode engaged. It's a meagre saving, but one that could add up over time – especially compared to some of the other routers on test this month, which can draw upwards of 12W while in use.

Unfortunately, this is the extent of the Hub 2's positive traits. It's largely unchanged from the original

ABOVE The Hub 2's ageing hardware severely restricts performance

Sky Hub, with the same wireless antenna array restricting it to 2.4GHz, single-band, 2x2-stream Wi-Fi networks. This is shocking, since all the other major UK ISPs have upgraded their bundled routers to dual-band or even 802.11ac Wi-Fi. Amazingly for a modern router, there's also no IPv6 support.

It's a similar story with regard to wired connectivity. The four Ethernet ports operate at 10/100 Ethernet, rather than Gigabit speeds. Should fibre broadband speeds increase beyond the current maximum of 76Mbps/sec during the life of the router, there would be no way to use all that bandwidth with this hardware. There's no USB port, either, so you can't share external storage or a printer over the network.

Unsurprisingly, the Hub 2 was one of the slowest routers on test this month: third-party models carved out a speed advantage of almost sevenfold, thanks to faster wireless support. Sky's router couldn't even impress in terms of 802.11n speeds, due to the absence of a 5GHz band. At close range, it could only manage a pitiful 11.6MB/sec. Things improved compared to the opposition at long range, but not enough to matter.

Get the most from your Hub 2

There's no escaping the fact that the latest Sky Hub is the runt of the pack when it comes to ISP-supplied routers. However, if you don't plan on swapping it out for a different model any time soon, there are a few things you can do to make it slightly better in day-to-day use.

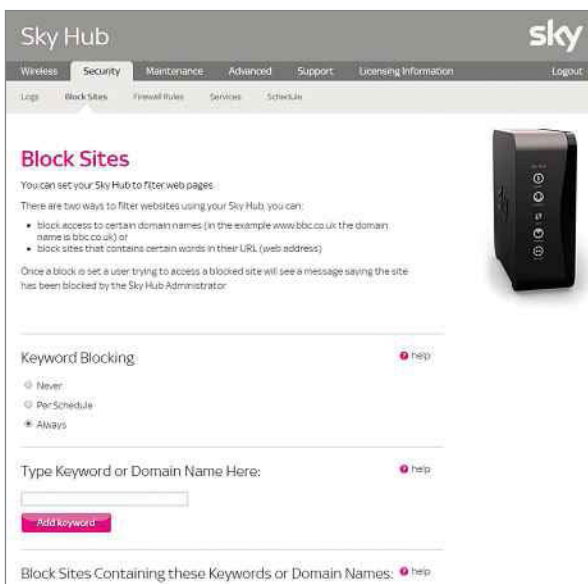
You'll need to log in to the web interface to do so, but the default admin username and password aren't written on the router itself. Unless you've changed them manually, you can get access using "admin" as the username and "sky" as the password.

The chief complaint among Sky Hub owners concerns whether the automatic wireless channel selection is working correctly. This is enabled by default, and while you can force the Hub 2 to use a specific channel, there's no tool in the web interface to help you work out which channel is the least congested. Instead, you need to use a third-party program and scan for network clashes yourself.



One of the best is InSSIDer: version 4 costs \$20 (£13) to download, but version 3 is now free. Once you've downloaded and installed it on a PC with a wireless network card, run it, double-checking that your wireless NIC is listed in the top-right corner. Click Start and wait for the list of networks to be populated. Even if there are networks with hidden SSID names, they will be displayed as a MAC address.

With all the nearby networks listed, look at the Channel column. You need to find a number between 1 and 11, the Sky Hub's available channels, that no other networks are using. Once you have one, log in to the Sky Hub, click Wireless at the top of the page, then click on the Channel dropdown. Enter your new channel and hit Save. Wireless devices will lose their connection while the change goes into effect, but they'll reconnect automatically, since the SSID name and password haven't changed.



It's a shame speed is such a problem, since the Hub 2 has a surprisingly comprehensive web interface, at least in terms of web security and content filtering. While other ISPs force you to use network-level restrictions, supplying routers that lack the settings to set up controls yourself, here you can block sites by keyword or domain name. This can be applied on a schedule basis or across the local network, with one trusted IP address allowed unfiltered access. Inbound and outbound firewall rules can be created with a few clicks, and a DMZ is available if required. There's even dynamic DNS support, which is unusual among ISP-supplied routers.

Wireless settings are the exception, but this shouldn't come as a surprise, considering it's a single-band router. Network security is reasonably well covered, with WPA encryption, and you can toggle whether or not to broadcast the SSID name, but there aren't many more settings you can tweak. The SSID broadcast channel can be changed manually, but doing so didn't result in any meaningful performance boost over the default automatic mode.

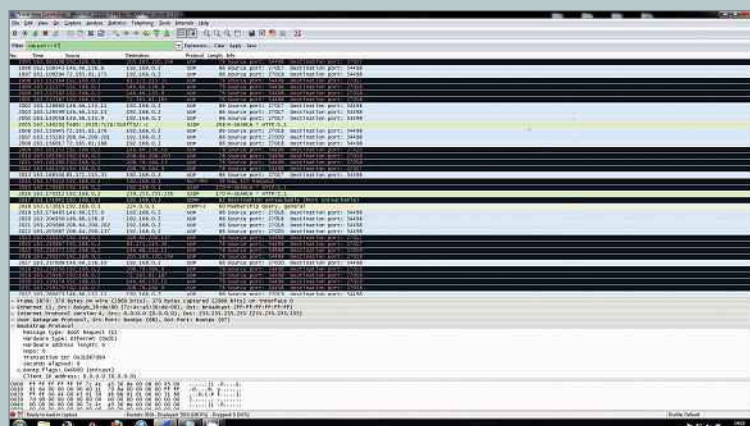
With ageing hardware that severely restricts wired and wireless performance, the Sky Hub 2 is a real disappointment. If customers weren't given it for free it would be a travesty, and even then it doesn't compare well to other ISP-supplied routers. While there are a few useful software tweaks, and it's very power-efficient, we strongly recommend switching to a different router.

ABOVE The web interface allows users to block sites by domain name and keyword

BELOW The Ethernet ports operate at 10/100 Ethernet, rather than Gigabit



How to switch to another router



Sky doesn't make it easy for customers to replace the Hub 2 with a third-party router – in fact, doing so when you're on a fibre broadband package is actually in breach of the contract's terms and conditions. If you need technical support, Sky won't give it to you while you're using a different router.

That said, switching is possible. Your third-party VDSL modem-router must be MER-compatible (MER stands for MAC encryption router, and Sky uses it specifically to restrict third-party routers) and support VDSL option #61 (ClientID field); otherwise, you'll need a BT Openreach VDSL modem.

To make the switch, you need to establish your Sky username and password. Unfortunately, these aren't the same as your My Sky or other login details. Thanks, Sky. Wireshark (wireshark.org) is a free program that can help: once you've downloaded and installed it, run the program and reboot your router.

Hit Start Capture in Wireshark and let it run for a minute or two, until you see DHCP packets being captured. Enter "udp port == 67" into the filter at the top of the screen and hit Apply. Click on any of the discovered DHCP packets, then click on the "+" box next to Bootstrap Protocol to expand the options. Scroll through this list until you see "Option 61: Client identifier".

Right-click it, select Copy, then Bytes, then Printable Text Only. Open Notepad and paste. This should leave you with a username and password that looks something like XXXXXXX@skydsl123abc. Save this for reference when setting up your new router.



If you're using an Openreach modem, now is the time to plug it in and connect it to one of your new router's LAN ports. If you aren't, plug the VDSL cable into the relevant port on your new router and switch it on. You'll then need to log in to your new router and add your Sky login and password in the WAN section, typically under "Special Requirements from ISP". Look for "Manual client ID" or a similar phrase; this is where to put your Sky details. Click Save/Apply, then reboot the router. All being well, you should now be connected.

ADSL customers don't really have it any easier. While you could use the Sky Hub in bridge mode, you would be speed-limited by its 100Mbps/sec Ethernet connections, so it makes more sense to replace it with an ADSL modem router. You'll still need to follow the instructions above to get your Sky username and password, but you'll need to enter them slightly differently in your replacement router. Once it's set up and you've logged in to the web interface, look for the WAN Settings page. Enter your username and password in the relevant boxes, change encapsulation method to PPPoA, change VPI to 0, change VCI to 38 and set Multiplexing to VC (if the option is available). After applying your new settings and rebooting your router, you should regain internet access.



TalkTalk HG635 Super Router

Better performance than you might expect, but features are lacking

SCORE ★★★★★

PRICE Free from talktalk.co.uk

Despite its grandiose name, the TalkTalk Super Router looks anything but. Don't let that fool you, though, because the ISP has partnered with Huawei to bring its customers a well-equipped product, complete with a choice of Gigabit WAN or VDSL connections for either of TalkTalk's broadband services. This means you won't need a separate Openreach modem to get online. You'll still need to wait for an Openreach engineer to switch you over at the cabinet if you haven't had fibre broadband before, but if you order your package online TalkTalk will waive the £50 installation fee.

There are four Gigabit Ethernet ports, which will ensure any wired devices get the most from your internet connection. The USB port is a useful inclusion, allowing you to share external storage across a network, but the controller only operates at USB 2 speeds. This hobbles transfer rates: a top speed of only 10MB/sec is disappointing and pales in comparison to other routers. Both DLNA and SMB media shares are supported, at least, and you can also use the USB port to share a printer across the network.

With a 3x3 MIMO antenna configuration and beamforming, the Super Router can deliver maximum



link speeds of up to 1,300Mbps/sec over 802.11ac and 450Mbps/sec over 802.11n. Annoyingly, however, it broadcasts its 2.4GHz and 5GHz frequencies under the same SSID by default, meaning it can be difficult to tell if your devices are making the most of the 5GHz band. You can change this in the router's web interface, but you can't have different passwords for each SSID. There are no guest networks, either, which can be frustrating if you need to keep part of your network secure from visitors.

With the wireless frequencies split into two SSIDs, the Super Router

produced excellent speeds. At close range, 77.5MB/sec over 802.11ac was faster than both Virgin's Super Hub 2ac and BT's Home Hub 5, and 17.1MB/sec over 802.11n on the 5GHz band is essentially the best speed possible from a 2x2 stream device. Performance over 802.11ac was consistent over long range, with a fantastic 32.5MB/sec trouncing all the other ISP-supplied routers and even comparing favourably to pricey third-party models. The same can't be said of 802.11n on the 5GHz band, with file transfers dropping to 8.4MB/sec – the poorest result in this Labs.

Like many ISPs, TalkTalk wants its customers to use a network-level content-blocking system – in this case, HomeSafe. This checks incoming traffic for malware, blocks access to websites based on categories, and restricts access to social networks and games at specific times. You can also block specific website URLs, but the setup and configuration is all done through the TalkTalk web page, rather than on the router itself, and the blocks apply to everyone using the connection, not just specific devices.

The Super Router has its own set of parental controls, which can be

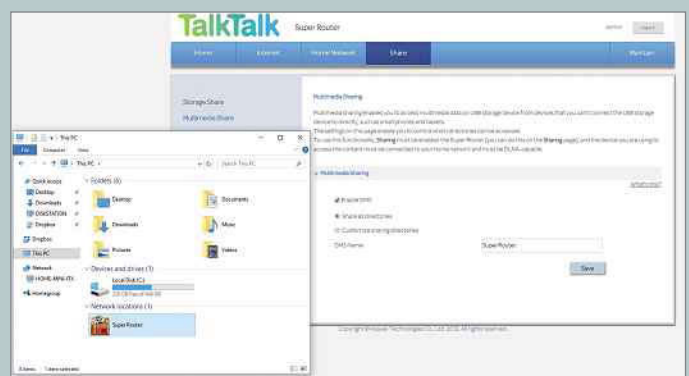
ABOVE The Super Router isn't a looker, but it's well equipped

Get the most from your Super Router

One thing that might encourage you to hold on to your Super Router, rather than replace it, is the comparatively high 802.11ac speeds; on paper, it's faster than all the other ISP-supplied models in this month's Labs. If you want to explore its additional features, you'll need to log in to the web interface by pointing a browser to <http://192.168.1.1>. The default username and password are both "admin".

By default, the Super Router is set to pick the best wireless channel based on interference from other devices. It doesn't always get it right, however, so it can be better to assign a specific channel manually. After logging in, select Home Network from the menu bar at the top, then Wireless Settings on the left of the screen. Open Advanced Settings, then click on the dropdown arrow next to the channel. Select a new channel and click Save at the bottom of the page. Any connected wireless devices will lose their connection, but they should reconnect automatically, since the SSID name and password won't have changed.

Sharing external storage on the network is a little more complicated than plug and play. You'll need to create a username and password before you can access a flash drive or external hard disk through Windows using SAMBA. Log in to the router, click Share at the top of the screen and make sure the



box next to Enable SAMBA is ticked. Then click on User Settings | Add a User. Type in a username and password, decide whether to give the account read and write access or read only, then click Save. You can then map a network drive in Windows using the default address [//192.168.1.1/](http://192.168.1.1/).



applied on a schedule and to specific devices, but it's only available through the URL http://192.168.1.1/html/advance.html#parent_control – there's no way to access it normally through the web interface.

This is a shame, since the rest of the web UI is sensibly laid out and perfectly functional. The homescreen includes a network map for checking which devices are connected across wired, wireless and USB, with more advanced features hidden in separate menus. Dynamic DNS (DDNS) is welcome, and not guaranteed in an ISP-supplied router. You also get a demilitarized zone (DMZ) and the usual selection of port-forwarding/mapping options. Unfortunately, making any changes can take a while – the interface is slow to refresh and must do so after every change.

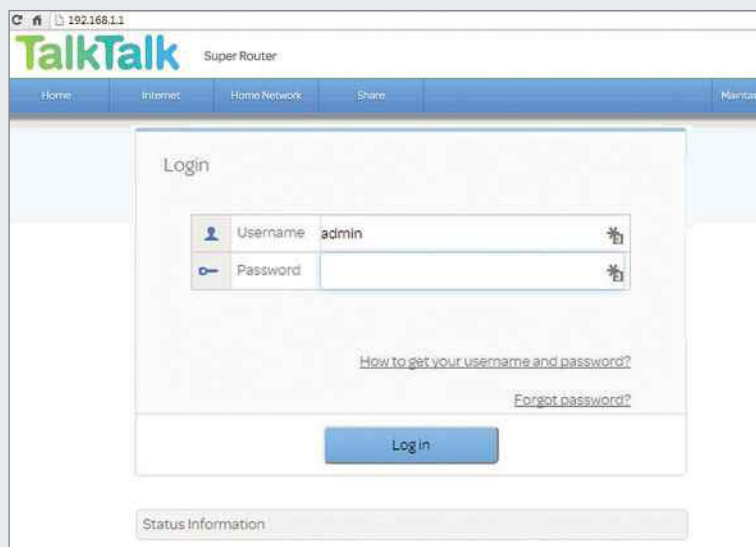
TalkTalk's router is among the fastest ISP-supplied models available over 802.11ac, both at close and long range. The web interface is user-friendly, but it lacks many of the features that advanced users rely on, including guest networks and a convoluted bridge mode. Available for nothing to all new users, it's an excellent starter router that's miles better than previous TalkTalk models. Existing users can upgrade for free, too, in exchange for signing a new 18-month contract, making it fantastic value. The only reasons to consider upgrading to a different router is to get faster performance on the 2.4GHz band in long range, or if the meagre set of software features don't suit your needs.

ABOVE The web UI includes a network map for checking connected devices

BELOW Users can choose from Gigabit WAN or VDSL connections



How to switch to another router

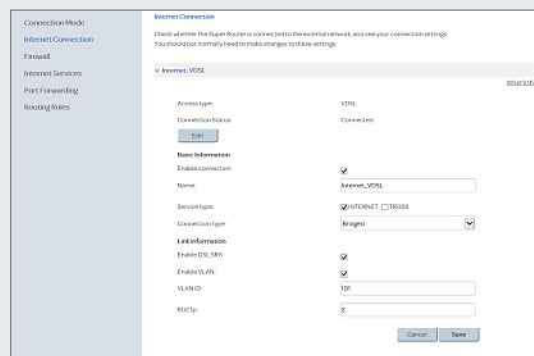


Like Sky, TalkTalk supplies both fibre-to-the-cabinet and ADSL broadband. The service you subscribe to will limit which routers you can use to replace the Super Router. If you have a TalkTalk YouView box, you'll need to make sure the new model supports IGMP proxy and IGMP snooping or you'll lose access to certain IPTV channels.

Switching is straightforward if you're on an ADSL package: you need only your TalkTalk username and password. Your username is almost always your telephone number followed by @talktalk.net, and if you can't remember your password you can call 0870 087 5562 from your TalkTalk land line to get a reminder.

Once you've plugged in your new router, log in to the web interface and look for the WAN settings page. Add your username and password to the relevant boxes and make sure Encapsulation is set to PPP over ATM (PPPoA) using VC-MUX. Other settings you might need to change include VPI: 0, VCI: 38 and MTU: 1432. Hit Save/Apply and reboot your router. When it comes back online, you should be connected.

VDSL customers don't need a username or password; these are provided on the network end and can be discovered automatically by your new router. Plug the VDSL cable into the matching port on your router and power it on. Log in via



the web interface and find the WAN settings page. You'll need to make sure the encapsulation mode is set to PPP over Ethernet (PPPoE), and you must change VLAN MUX ID to 101. The MTU must also be set to 1492. With those changes made, click Save/Apply and reboot the router. When it restarts, you should be reconnected to the internet.

If you've bought a router without a VDSL modem, you'll need to put the Super Router into bridge mode and use it simultaneously with its replacement. Unfortunately, it's not as simple as ticking a box in the Super Router web interface; you must log in, click on Internet at the top of the screen and then Internet Connection on the left-hand side. Click on New WAN Connection, then click Edit on the new entry that appears.

On the next screen, call the new connection "Bridge mode" to avoid confusion, change Access Type to PTM Uplink and Connection Type to Bridged. Tick the box Enable VLAN and enter 101 as your VLAN ID. In the box below it, marked 802.1p, enter 2. Click Save, then plug the Super Router into your new router.

Log in to your new router and look for the WAN Settings page. Change the connection type to DHCP/Automatic IP and reboot. It should now work correctly in bridge mode. You may also want to switch off Wi-Fi on the TalkTalk router to avoid creating Wi-Fi congestion for the replacement model.



Virgin Media Super Hub 2ac

Better performance than previous models, but still very restrictive in terms of features

SCORE ★★★★★

PRICE Free from virginmedia.com

The third-generation Super Hub router is Virgin's fastest yet: it finally gains 802.11ac Wi-Fi, giving it significantly improved wireless speeds compared with the previous model, which made do with dual-band 2.4GHz and 5GHz frequencies over 802.11n. With three 5GHz antennae, it has theoretical maximum link speeds of 1,300Mbps/sec over 802.11ac, although it makes do with two 2.4GHz antennae.

The Super Hub 2ac is provided free of charge to all new Virgin Media cable broadband customers, but it isn't available as an optional upgrade to existing customers – the only choice for owners of the original Super Hub is to pay £50 for the Super Hub 2.

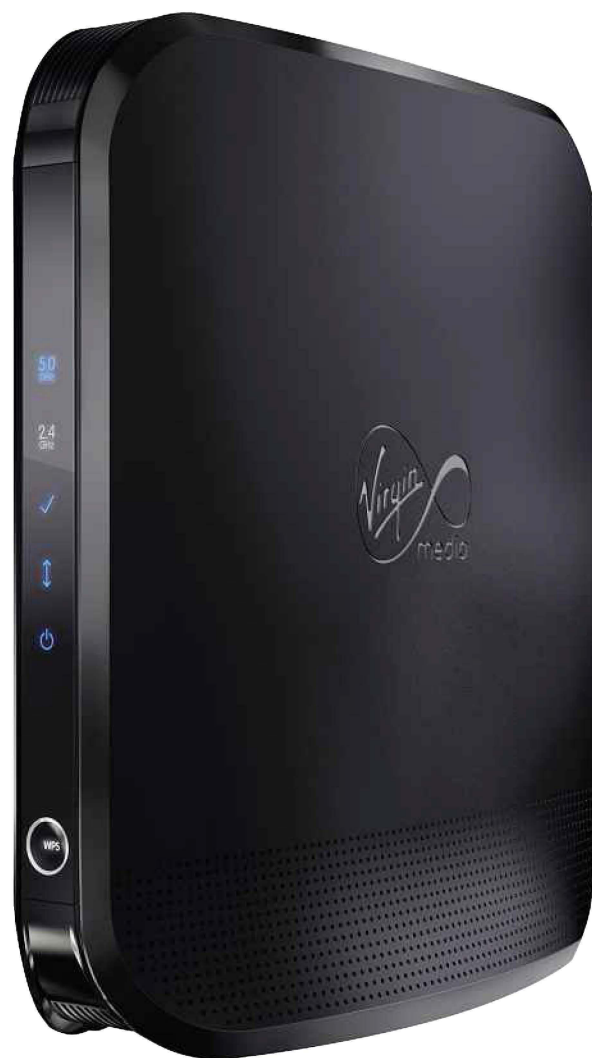
As is standard with all Virgin Media hardware, you don't actually own the router: it remains the property of Virgin throughout its lifetime, which means you can't sell it on – although, considering it's hard-coded with your account details before it arrives at your home, it's not much use to

anyone else anyway. At least you get peace of mind, as the company would have to replace it should it fail.

The Super Hub 2ac looks virtually identical to the old model, which is unsurprising, considering they're both Netgear-manufactured routers. There are still four Gigabit Ethernet ports as well as the cable connection, which should ensure wired devices get the most out of your broadband package. However, it's otherwise lacking when it comes to connectivity, with no support for external storage devices. This was true of previous models, too, but it's now one of only a few ISP-supplied routers without a USB port.

The Super Hub 2ac creates a separate wireless SSID for each frequency band; the default SSIDs and passwords are written on a sticker on the bottom of the router. This is also where you'll find the default web interface address and password, as well as the WPS pin. To save time when setting up new devices, press the WPS button on the front of the router.

Little has changed on the software front: the web interface looks almost identical to that of



ABOVE Unlike many ISP-supplied routers, the Super Hub doesn't have a USB port

the previous Super Hub. Wireless channels are assigned automatically, but the router can't detect sources of interference and can't change channels on the fly. You can set them manually if you prefer, but there's no channel scanner to help you identify the clearest channels. The Advanced Settings screen is disappointingly

Get the most from your Super Hub 2ac

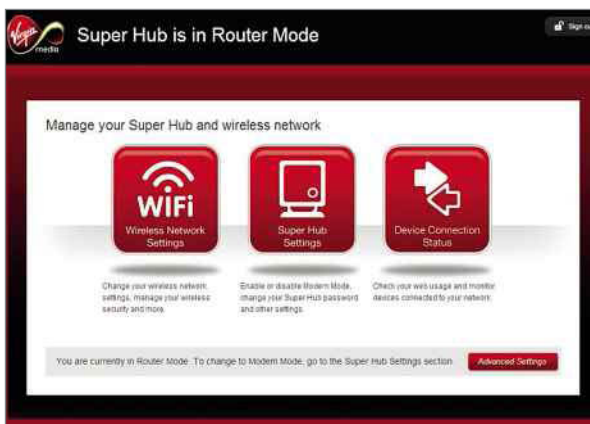
It might be basic, but there are a few things you can do to make your Super Hub more useful. The tips below are all done through the web interface, which by default is found at <http://192.168.0.1>. You'll need to type in the settings password and WPS pin code to access it; unless you've changed the password manually, both can be found on a sticker on the underside of the router.

By default, only the primary 2.4GHz and 5GHz wireless networks are enabled, but you can add up to two guest networks on each frequency band. Click Advanced Settings and then choose one of the guest networks; this will open a new window that lets you set SSID, security mode and MAC-address filtering. Clicking Apply will begin broadcasting a secondary network that prevents visitors from accessing network shares.



If you followed the advice in the boxout on the opposite page, but you've changed your mind and want to switch the Super Hub back from modem mode to hub mode, there are two options. The first is a pinhole reset, but this will also erase any custom settings you had on the router before you made the switch originally, including wireless SSIDs and passwords, forwarded ports and DHCP-reserved IP addresses.

If you want to keep these settings, you'll need to log in to the router using the new IP address 192.168.100.1. You'll need to log in using your admin password and WPS pin. Once you're in, click Super Hub Settings, then scroll down and click the Disable Modem Mode button. A pop-up will appear asking to confirm the change. Click Yes and the Super Hub will reboot into hub mode.



basic, too, with options to enable port forwarding and configure DHCP, but none for quality of service, dynamic DNS or parental-control restrictions.

The one saving grace is the guest network setting, which allows you to create up to four additional Wi-Fi SSIDs for visitors: two for 2.4GHz, two for 5GHz. Each has its own security setting, passphrase and MAC-filtering list, which makes the Super Hub 2ac easily the most comprehensive ISP-supplied router around in terms of network sharing.

It's also adept when it comes to wireless performance, at least at close range. Over 802.11ac, transfer speeds hit a peak of 69MB/sec. That's respectable for an ISP-supplied router, beating BT's Home Hub 5, but falling behind the TalkTalk Super Router. All three were consistent over 802.11n, with the Super Hub managing 17MB/sec with a 2x2-stream device over 5GHz, and 11.7MB/sec with a 3x3-stream device over 2.4GHz.

However, things weren't quite so positive when we moved to our long-range tests, with transfer speeds dropping to 22.2MB/sec over 802.11ac. Performance remained strong over 802.11n, though, with a 3x3-stream device managing 7.5MB/sec on the 2.4GHz band and a 2x2-stream iPad mini reaching 9.9MB/sec on the 5GHz band.

The Super Hub is perfectly suitable for wired networking, but wireless speeds aren't the best, and it lacks many of the features that come as standard on third-party routers. This may be to avoid confusing customers who only need internet access, but it's a shame that features such as parental controls aren't available in the Advanced Settings menu.

If you want more than basic networking, we thoroughly recommend setting the Super Hub to Modem mode and buying a separate router.

ABOVE The Advanced Settings screen in the web interface lacks parental controls or dynamic DNS

BELOW As well as the cable connection, there are four Gigabit Ethernet ports for wired devices



How to switch to another router

Remote Access

Enable or disable remote access to your Super Hub.

Enable Remote Access on Port **8443**

Modem Mode

When active, Modem Mode disables the wireless and routing functions of your Super Hub so you can use your own wireless router. For more information please visit <http://www.virginmedia.com/help>.



Active Ports & Connections

When in Modem Mode, only one Ethernet port will be active on your Super Hub, so when using your own router make sure it's connected to the active port as shown in the image to the left. Alternatively, connect a computer or games console directly to this port. When you are in Modem Mode, to access the Main Menu type 192.168.100.1 into your internet browser.

Enable Modem Mode

Super Hub Version

Software Version **"V1.01.11"**

Hardware Version **1.03**

Because cable broadband isn't as widely used in the UK as in other countries, there are few third-party routers capable of replacing it completely. Each Super Hub is also registered to an individual account, with login details saved to its firmware, which makes ditching it for another model practically impossible. In fact, none of the routers in this month's Labs have a dedicated cable connection; they all rely on a separate modem. That means you'll need to switch the Super Hub into modem mode when you're ready to upgrade and use it simultaneously with your new router.

Before you unplug anything, you'll need to enter the web interface and log in with your password. If you're still using the default password, you'll need to supply your WPS pin code. Both can be found on the bottom of the router. From here, click Super Hub Settings and then click Modem Mode. Choose Yes in the pop-up that opens and wait for the router to reboot. The Wi-Fi networks and three of the four Ethernet ports will then be disabled, leaving a single Ethernet port free to connect to your new router. If the LED on the front of the router then glows purple, rather than blue, it has worked.

Plug this in to the new unit and log in to the web interface. You'll need to switch it from router mode to access-point mode; the process for doing so varies between models, but it should take only a few minutes. Search for WAN Settings in the web interface, and look for a dropdown box labelled Connection Type. Change this to DHCP/Automatic IP then save and reboot. Once the new router has rebooted, you should regain internet access.

Welcome to your Virgin Media Super Hub 2ac



Sign In to view and change your settings

Settings Password

WPS PIN

Sign In

Don't know your password?
You'll find your default password on the bottom of your Super Hub.



Netgear Nighthawk X4S

A future-proof and exceptionally fast router that's ready for all types of connections

SCORE ★★★★★

PRICE £225 (£270 inc VAT) from broadbandbuyer.co.uk

The Nighthawk X4S is a world first: it's the only DSL modem router that supports Wave 2 Wi-Fi, quad-stream on both bands and multi-user MIMO (MU-MIMO). Typically, Wi-Fi signals are shared among devices from a single pool, with less bandwidth available as more devices connect to a network. MU-MIMO lets a router broadcast a signal from a number of sources to multiple systems simultaneously, directing separate bandwidth streams to up to four devices, as long as the devices are MU-MIMO compatible.

With the addition of quad-stream broadcasting on both frequency bands and beamforming, the Nighthawk X4S has a whopping maximum bandwidth of 2.53Gbits/sec, with 800Mbits/sec on the 2.4GHz band and 1,733Mbits/sec over 5GHz. However, this presents a problem. The only way to get the best possible wireless speeds is via a 4x4-stream, MU-MIMO-compatible network adapter, but no such component exists. You could use two routers in bridge mode, but this isn't representative of real-world use.

We tested with an AC1900, 3x3-stream Wi-Fi card, one of the fastest NICs you can buy today. It can't max out the Nighthawk 4S, but it indicates what performance would be like right now.

In our close-range tests, file-transfer speeds over 802.11ac – 73.3MB/sec – were seriously quick, albeit not as fast as some tri-band models. Taking bandwidth overheads into account, 17.1MB/sec over 5GHz 802.11n was an excellent result. Long-range results over 802.11ac were only average, at 22.2MB/sec, but 14MB/sec over 5GHz 802.11n was one of the fastest speeds we saw in this month's Labs. When the right hardware arrives, the Nighthawk X4S should be blazingly fast; right now, it's able to hold its own against the competition.

Naturally, there are four Gigabit LAN ports for speedy wired performance, along with a Gigabit WAN port for a separate cable or

fibre modem. With both ADSL and VDSL modems onboard, however, you won't need two separate boxes next to your phone line unless your ISP forces you to use its own hardware. The eSATA port is an odd inclusion: while it could be useful for legacy devices, the two USB 3 ports on the side will be much faster. We measured file transfers at 82.3MB/sec, which is practically quick enough for the router to double as a NAS device once you attach an external hard disk. Connecting a printer to the second USB port will turn it into an Apple AirPrint-enabled device.

Netgear has retained the outlandish looks used for the original Nighthawk AC1900, making the X4S look more like a stealth bomber than a wireless router. It's huge, but the four removable, adjustable antennae will let you fine-tune the spread of its wireless networks.

The web interface also remains unchanged, which is unfortunate: compared to Linksys' excellent Smart Wi-Fi or Synology's SRM, Netgear's user interface feels very basic for such a high-end router. At least it's responsive, with a 1.4GHz dual-core

ABOVE The X4S keeps the Nighthawk range's trademark stealth-bomber looks



BELOW The Netgear is seriously quick over close range



processor handling the grunt work. There are still plenty of manual settings and all the features you'd expect, including VPN access and Netgear's excellent Live Parental Controls. This lets you sign up to the URL blacklists maintained by OpenDNS in only a few clicks, with the ability to block websites by category or apply different filters on a set schedule.

Dynamic quality of service (QoS) is another welcome addition, quickly reconciling individual applications running on each connected device and prioritising network traffic accordingly. This helped prevent video buffering when watching a Netflix stream, even with three smartphones on the network simultaneously downloading an iOS firmware update. Netgear's Genie smartphone app makes a reappearance, too, letting you monitor the network without having to log in on a PC first.

There's no escaping the fact that the Nighthawk X4S is expensive, and anyone with an ADSL connection won't get any benefit from having a VDSL modem onboard. It's already exceptionally fast and when MU-MIMO devices arrive in greater numbers it will stay fast – unlike its rivals – even when you have multiple wireless clients connected at once. Features such as dynamic QoS truly make a difference to networks with multiple connected devices, and wireless range is excellent. That's why it's our top choice.

Synology RT1900ac

Great performance, but it's a combination of features, ease of use and sheer value that earn it an award

SCORE ★★★★★

PRICE £96 (£115 inc VAT) from synology.com/uk

Synology produces some of the best NAS devices around, but the RT1900ac is the company's first attempt at a wireless router.

Looking at the specification sheet, there doesn't seem to be much to separate it from the competition: it's a 3x3-MIMO-stream, simultaneous-dual-band router, with a maximum 1,300Mbps/sec link speed over 802.11ac and beamforming support. However, the user interface sets the RT1900ac apart from its rivals.

Synology has taken the familiar DiskStation Manager (DSM) interface from its NAS range and reimagined it as Synology Router Manager (SRM). They're very similar, so Synology NAS owners will feel right at home. The web interface feels like a desktop OS, with separate windows and shortcuts to settings and features. All the crucial network settings are ordered sensibly in the Network Center app, with a network map showing which devices are currently connected and a traffic control page allowing you to give priority to specific devices. The grid-based parental-control scheduler is fantastic, letting you quickly drag and select blocks of time to limit access to certain websites.

Even the initial setup is straightforward, with a quick guide walking you through each step. It also forces you to create a unique username and password, which should boost security; many of the routers in this Labs default to admin/admin and don't prompt you to change them when you first log in.

This simplicity belies a wealth of options to keep network administrators happy, including upload/download limitations per service or application, QoS prioritisation, dual guest Wi-Fi networks and VPN access. The dual-core, 1GHz processor, 4GB of flash storage and 256MB of RAM keep the interface ticking over smoothly, even when you have multiple windows open at once.

A package manager lets you download additional services and

features, with many transitioning from DSM. Download Station, Audio Station, Photo Station and Video Station are all present and correct, letting you access multimedia files or queue up torrent files remotely using smartphone companion apps and Synology's QuickConnect dynamic DNS service.

With an SD card reader in addition to a USB 3 port, you could add 128GB of flash storage and not need to make room for an external hard disk next to the router. (Don't expect blistering speeds, though: USB 3 file-transfer performance was merely respectable, at 53.7MB/sec.) The port can also be used with 3G/4G mobile broadband dongles as a backup, in case your primary connection fails. A dedicated DS Router app is also available for Android and iOS for applying parental controls, checking the number of connected devices and tweaking firewall rules.

The RT1900ac features a number of neat touches, such as the ability to schedule when the activity LEDs on

ABOVE The inclusion of an SD card reader means you can add 128GB of flash storage



BELOW The three antennae are removable and adjustable



the front of the unit are switched on: turning them off between midnight and 7am could help you get to sleep if the router is located in a bedroom, but they'll be on during the day for troubleshooting.

There's little on the outside to indicate the software excellence within; the RT1900ac is diminutive. The two feet on the back help elevate the unit to keep it cool, but otherwise it's a nondescript black box. The four Gigabit LAN ports and single Gigabit WAN port are par for the course, as are the three removable, adjustable antennae that let you fine-tune the coverage of your wireless network.

Wireless performance was very good at close range, with 78MB/sec over 802.11ac narrowly falling behind the Asus RT-AC3200 but besting all the ISP-supplied routers. Over 5GHz 802.11n, 16.6MB/sec is approaching the top end of a 2x2-stream device's capabilities; other routers are faster, but not by much.

Moving to long range, 802.11ac performance was consistent, with 27.8MB/sec falling only just behind the fastest models on test. A 5GHz 802.11n result of just 9.2MB/sec is slightly below average, however.

With such a strong set of performance figures coupled to an amazing price, the RT1900ac would stand up on its own even without Synology's fantastic user interface. SRM makes all the difference: it's responsive, user-friendly without excluding advanced features, and unbelievably flexible. It's better than any other router UI we've used before and sets the gold standard for the competition in future.



Asus RT-AC3200

Blisteringly fast – and tri-band Wi-Fi lets multiple users get maximum wireless speeds

SCORE ★★★★★

PRICE £171 (£230 inc VAT) from currys.co.uk

The RT-AC3200 is built for speed. It features six removable, positional antennae and two 3x3-MIMO-stream 802.11ac wireless networks, giving a maximum link speed of 1,300Mbps/sec on each 5GHz band. The tri-band router also uses Smart Connect to steer wireless clients automatically to one of the three radios, maximising the total wireless throughput, although all three networks must broadcast under the same SSID to use it.

Finding and configuring features such as this is a breeze, thanks to the delightfully simple ASUSWRT web interface. It has a straightforward layout, with a network map giving at-a-glance information on the

number of connected clients. Widgets and graphs simplify more complex features such as QoS and traffic analysis, but you can also drill down into individual advanced settings such as VPN access, web-content filtering and access scheduling.

In common with most tri-band routers, the RT-AC3200 is massive, with four Gigabit Ethernet ports, a Gigabit WAN port and a USB 2 port on the rear. It supports dual WAN, letting you assign one of the LAN ports or a 3G/4G mobile broadband dongle as a backup in case your primary connection goes down. The USB 3 port on the side is hidden behind a removable panel and supports Time Machine backups, network printers and storage sharing. However, file-transfer speeds weren't outstanding at 62.4MB/sec.

The same can't be said of wireless performance, as the RT-AC3200 is one of the fastest routers around over 802.11ac. At close range, it managed fantastic 84.3MB/sec file transfers, with 17.1MB/sec speeds over 802.11n



ABOVE It's a large router, but in return you get truly chart-topping speeds

putting other routers to shame. Performance over 2.4GHz with a 2x2-stream iPad mini wasn't perfect at 9.6MB/sec, but this is still above average. At range, the RT-AC3200 picks up the pace again, with 30.8MB/sec transfers over 802.11ac, hot on the heels of the D-Link.

The RT-AC3200 is incredibly fast over all distances, with Smart Connect tri-band wireless coming into its own when several clients use the network at once. If this is your priority, then it's an excellent choice.

D-Link DIR-890L

Excellent wireless speeds, but this tri-band Wi-Fi doesn't stand out from the crowd

SCORE ★★★★★

PRICE £208 (£250 inc VAT) from dabs.com

The DIR-890L isn't exactly subtle, with its huge dimensions, red metal finish and UFO-like styling, but there's a good reason it takes up so much space. It's a tri-band router, broadcasting two 5GHz networks simultaneously to double the available wireless bandwidth and allow two devices to get a theoretical maximum link speed of 1,300Mbps/sec over 802.11ac. Smart Connect means you won't need to choose which band to use manually but, as with the Asus above, this only works if all three wireless SSIDs share the same name and password.

It backed up the bravado with performance, managing 74.8MB/sec file transfers over 802.11ac at close range. On the 5GHz band, 2x2-stream

devices proved equally fast, reaching 18MB/sec, and at long range a score of 32.8MB/sec makes this the quickest 802.11ac router in this month's Labs.

The six antennae are non-removable, but they can be adjusted for fine-tuning the spread of your networks. Their positioning should help eliminate dead spots, too.

All the ports are hidden at the back. There's a single Gigabit WAN, four Gigabit LAN ports and two USB ports, although only one is USB 3. It's backed by a fast controller, transferring files from a USB SSD at 73.8MB/sec. External storage can be accessed over the internet using D-Link's SharePort smartphone app.

Previous D-Link routers were saddled with a clunky web interface that hadn't changed in what felt like forever, but the DIR-890L finally moves on. The new-look UI is a massive improvement, with a simple layout and sensibly labelled tabs hiding the more advanced features from less experienced users. The network map on the homescreen



ABOVE The D-Link recorded the quickest long-range score over 802.11ac in this Labs

is a welcome touch, showing exactly how many wired and wireless devices are connected at a glance.

Like the Asus RT-AC3200, the DIR-890L will reduce the bandwidth strain on a wireless network congested with multiple devices. However, the D-Link wasn't quite as fast in our close range file-transfer tests, while its user interface is neither as comprehensive as that of the Asus, nor as intuitive as Synology's.

It's a fine tri-band router, but until the price drops it has nothing to make it stand out against the competition.

DrayTek Vigor 2860ac

The wireless speeds aren't great, but businesses should take note of the extensive features

SCORE

PRICE £208 (£250 inc VAT) from dabs.com

As one of the few dual VDSL/ADSL routers with integrated modems, the Vigor 2860ac has proven popular with home users looking to simplify their networking setup by ditching their Openreach modem and separate router. In reality, this is a router best suited to business rather than home use, with more office-friendly features than any other router in this month's Labs.

It has six Gigabit Ethernet ports – two more than most routers, and enough that it could make the difference between needing a separate network switch or not. There's also an RJ11 port for connecting a telephone and using the on-router VoIP client; it took less than ten minutes to set up a SIP

account for internet calls. One of the two USB ports can even be used with a 3G/4G mobile broadband dongle for redundancy in the event of a network outage. They only operate at USB 2 speeds, however, so transfer speeds were slow – 9.3MB/sec.

While DrayTek tends to concentrate on business-friendly features over outright speed, on paper the Vigor 2860ac looks to be the exception that proves the rule: it's the first with 3x3-stream, 802.11ac Wi-Fi with a maximum 1,300Mbps/sec link speed. Unfortunately, it produced disappointing results across the board, managing only 58MB/sec up close over 802.11ac and 17.1MB/sec over 802.11n. Speed takes a further hit at long range, with 802.11ac file transfers falling to 17.3MB/sec and 802.11n dropping further still to 3.7MB/sec.

It's a shame: with the ability to broadcast four separate SSIDs on each band, the Vigor would otherwise be ideal for segregating different parts of a wireless network. The web interface feels antiquated compared to Linksys' widget-based UI or Synology's excellent SRM, and with no search function it takes a lot of digging through menus to find



ABOVE The RJ11 port allows you to connect a telephone and use the on-router VOIP client

specific features. Still, there's no question it's comprehensive.

If you need total control over your network, the Vigor 2860ac is a seriously comprehensive router that's ideal for business use. The web interface is cumbersome yet feature-packed, and while wireless performance is disappointing, no-one comes close to matching its extensive security and network settings. The company performed well in the PC Pro Excellence Awards, too, scoring an overall satisfaction rate of 90%.

Linksys WRT1900ACS

Fans of Linksys routers won't be disappointed, but it's made to look average in this company

SCORE

PRICE £191 (£230 inc VAT) from amazon.co.uk

On paper, the WRT1900ACS looks like an iterative update of last year's WRT1900AC. Both have 3x3-MIMO-stream 802.11ac Wi-Fi for a 1,300Mbps/sec top link speed on the 5GHz band; both have surprisingly comprehensive open-source support, should you want to replace the default Linksys firmware; and both have the same distinctive blue-and-black chassis, a homage to the WRT54G router, which was incredibly popular in the 1990s.

Built like a tank, the Linksys has four detachable, positional antennas, four Gigabit Ethernet ports and a single Gigabit WAN port. The eSATA port isn't practical any more, but it doubles as a USB 2 port. There's also

a USB 3 port, with an incredible amount of power behind the controller: transfer rates are blisteringly fast – 106MB/sec – making this the only router to take full advantage of external SSDs.

Linksys' widget-based Smart Wi-Fi front-end is still one of the most user-friendly on the market, and it's even more responsive here than it was on the WRT1900AC, thanks to a 1.2GHz, dual-core processor and 512MB of RAM – double what was available in the old router. There's still no search function, but settings and features are sensibly labelled, and you can pin the most frequently used tools to the homepage. The combination of the cleanly presented network map and QoS tools is useful for assigning priorities to specific devices.

The upgraded hardware hasn't created extra heat, and Linksys has removed the active cooling fan that was present on the outgoing model. Considering this rarely spun up anyway, it won't be missed.

The upgraded hardware has had a positive impact on network performance, but only compared to its predecessor. While 61.8MB/sec over 802.11ac up close is a respectable figure, it falls behind the routers from



ABOVE The Linksys offers blisteringly fast file-transfer rates

Asus, D-Link and Netgear. Over 802.11n, speeds of 15.9MB/sec and 11.2MB/sec are above average. Things don't really improve at range, with 22.2MB/sec transfers over 802.11ac falling in the middle of the pack.

We praised the WRT1900AC as a speed demon, but the same can't be said of its successor, simply because other routers have come further in the same time. Wired performance is superb and the web UI remains excellent, but Synology's RT1900ac outpaces it over Wi-Fi and is arguably more user-friendly.

TP-Link Archer C2600

A cost-effective choice if you want to stick with your ISP-supplied modem, and file-transfer rates are good

SCORE ★★★★★

PRICE £137 (£165 inc VAT) from [pcworld.co.uk](#)

Routers can rarely be described as stylish, but TP-Link has done its best with the Archer C2600. It's sleek and compact – until you screw on the four removable antennae. As one of only three 4x4-stream models in this month's Labs, it has a theoretical maximum link speed of 1,733Mbps/sec, which could make it seriously fast – if paired with compatible hardware. It also supports 800Mbps/sec on the 2.4GHz band, but only if you have an adapter that supports 256-QAM (TurboQAM).

The emphasis on speed continues on the rear, with four Gigabit Ethernet LAN ports and a single Gigabit WAN. The two USB 3 ports on the side are a welcome inclusion, particularly

because file transfers are rapid; with an external SSD connected, the C2600 managed 55.4MB/sec.

TP-Link's web interface strikes a fine balance between accessibility and advanced features, with a new design that's easy to navigate. The main screen opens on to a network map, revealing the number of wired and wireless devices and anything plugged into the USB ports, but there are also shortcuts to guest networks, parental controls and QoS for those more at home with networking. Those unfamiliar with the ins and outs of router management can use the Tether smartphone app instead, which retains most of the features of the web UI but adapts them for smaller screens.

Unsurprisingly, the Archer C2600 was exceptionally fast at close range over 802.11ac. We measured file transfers at 81.5MB/sec, putting it only slightly behind the Asus RT-AC3200 but ahead of all the ISP-supplied routers. Naturally, 802.11n speeds fell much shorter, but 16.4MB/sec from a 3x3-stream PC over 2.4GHz and 17.3MB/sec from a 2x2 iPad mini over 5GHz are still well above average. This was true at long



ABOVE The Archer C2600 was super-quick at close range over 802.11ac

range as well, with 29MB/sec transfer speeds over 802.11ac and 11.9MB/s speeds on 5GHz 802.11n.

There's no doubting the price is right with the Archer C2600. It's more than £100 cheaper than Netgear's Nighthawk X4S, despite both routers having 4x4-stream, 1,733Mbps/sec Wi-Fi. TP-Link's web interface is arguably more user-friendly than Netgear's, but if convenience is your main concern, the lack of a modem in the Archer C2600 gives the Nighthawk the edge.

ZyXEL Armor Z1

Against tough competition, nothing but the Armor's size makes it stand out – even at this price

SCORE ★★★★★

PRICE £137 (£165 inc VAT) from [dabs.com](#)

According to ZyXEL, the Armor Z1 is a Wave 2, 4x4-stream router, but unlike the Netgear Nighthawk X4S and TP-Link Archer C2600, it's merely MU-MIMO "ready". It's classed as AC2350, with a 600Mbps/sec maximum link speed on the 2.4GHz frequency, versus the 800Mbps/sec supported by true AC2600 routers.

That's not to say the Armor Z1 is slow, however. It managed to reach a top speed of 76MB/sec at close range over 802.11ac, which is above average for a router in its price range. As ever, 802.11n performance is noticeably slower, at 17.3MB/sec, but, again, this is on par with competing models. Unfortunately, results get worse over long range – 25.5MB/sec over 802.11ac

and just 10.7MB/sec on a 2x2-stream iPad mini over 5GHz 802.11n place the Armor Z1 firmly in the middle of the pack.

Frustratingly, the 5GHz frequency band defaults to a broadcast channel not covered by the European 802.11n standard. This can be changed through the web interface, but only in the Expert section – which is hidden behind an easy-to-miss link. Apart from this oversight, the web UI is relatively clean, with shortcuts to more advanced features running along the bottom of the screen and individual settings listed in a menu to the left. For novice users, though, the amount of information present on each screen could be overwhelming. There's also a smartphone app for diagnosing network issues, running speed tests and setting up guest networks without needing to log in to the router.

Despite the router being huge, the four removable, adjustable antennas are placed right at the back, rather than spread around. This is also where you'll find four Gigabit LAN ports and a single Gigabit WAN port. Two USB 3 ports are hidden behind a flap on the side. Files transferred from an external SSD at 79.7MB/sec, which is above average, but still slower than



ABOVE The Armor boasts more features than an ISP-supplied router, but it doesn't perform much better

the superfast Linksys WRT1900ACS.

While the Armor Z1 has all the advanced networking features usually missing from an ISP-supplied router, it doesn't dramatically outperform BT, TalkTalk or Virgin's own-brand models. With TP-Link's Archer C2600 providing faster wireless performance for the same money, there's not enough here to make it worth buying. ➔

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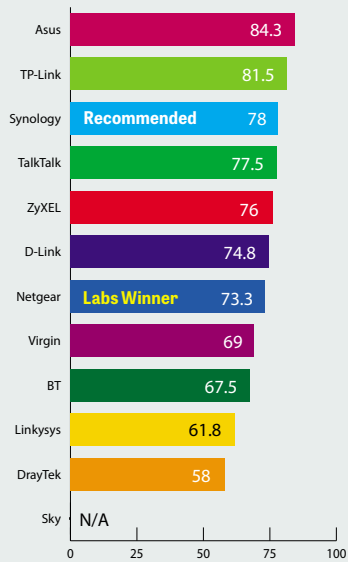
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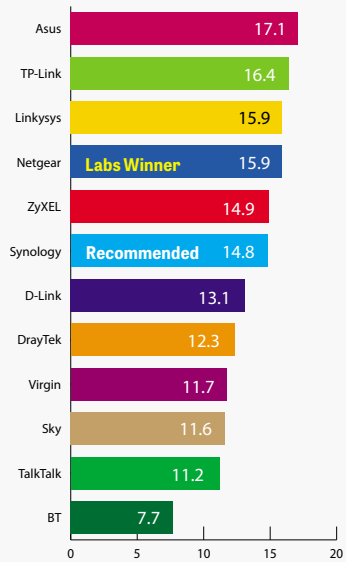


Test results

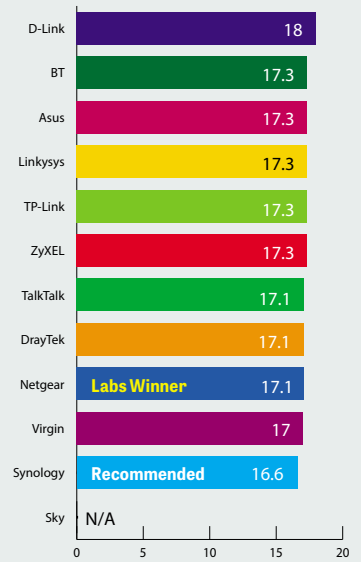
Close range, 802.11ac, 3x3, 5GHz MB/sec



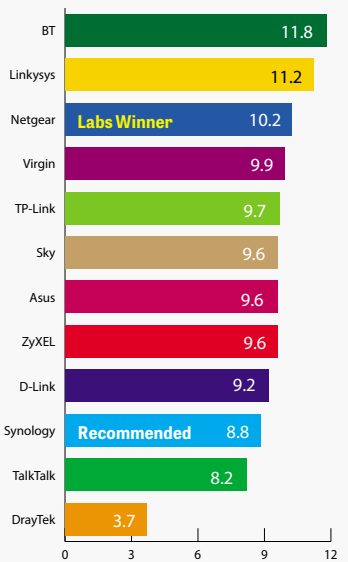
Close range, 802.11n, 3x3, 2.4GHz MB/sec



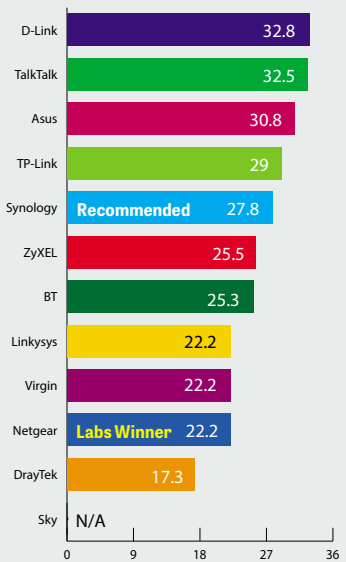
Close range, 802.11n, 2x2, 5GHz MB/sec



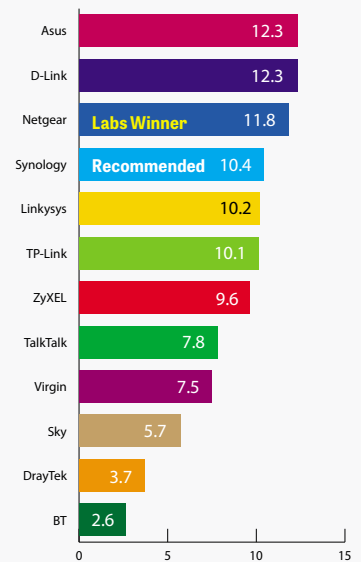
Close range, 802.11n, 2x2, 2.4GHz MB/sec



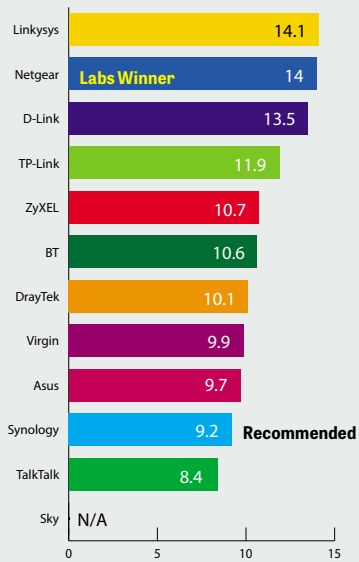
Long range, 802.11ac, 3x3, 5GHz MB/sec



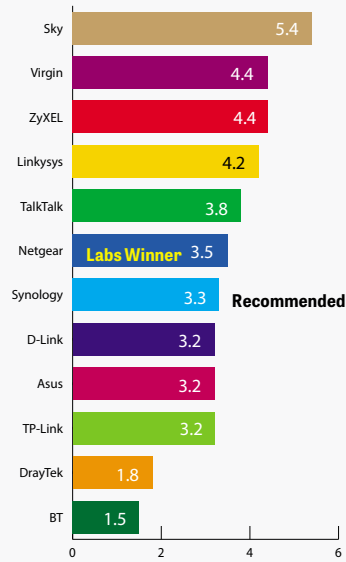
Long range, 802.11n, 3x3, 2.4GHz MB/sec



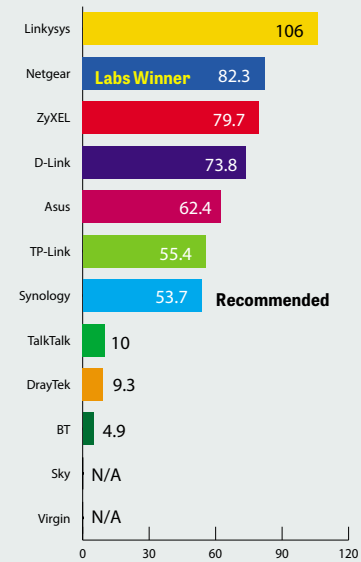
Long range, 802.11n, 2x2, 5GHz MB/sec



Long range, 802.11n, 2x2, 2.4GHz MB/sec



USB transfer speed MB/sec



View from the Labs

Tom Morgan looks forward to a world where all devices include fast wireless chips – and where manufacturers make it clear what’s inside their machines

When you get something for nothing, you don’t expect it to be the best. That’s definitely the case with many ISP-supplied wireless routers; you might not have to pay any extra to get one, but compared to almost all the third-party models on test this month, they’re disappointingly basic. Fast speeds are by no means guaranteed, parental controls are often limited to network-level protection, which limits everyone, and essentials such as guest networks can be missing in action, too.

There are plenty of reasons to upgrade, but the ISPs don’t exactly make this an easy task. In particular, Sky specifically prohibits the use of third-party equipment with its fibre broadband packages, although considering how abysmal its bundled router is, there’s plenty of reasons to ignore that particular clause of the Ts&Cs. Taking the time to dig out your login and password from a router’s web interface makes a lot of sense when you could double or triple your wireless speeds.

Making the jump from 802.11n to 802.11ac is a big part of that, which means you need devices to match. You probably already own laptops, phones and tablets that can take advantage of the extra bandwidth; Apple’s MacBooks have supported it for two years now, flagship smartphones such as the Samsung



Tom Morgan is
product editor
on our sister site
Expert Reviews

“Many manufacturers seem to obfuscate antennae configuration information. Anyone would think they had something to hide”

Galaxy S6 and the HTC One M9 include the technology, and many of the laptops and tablets that have passed through the *PC Pro Labs* in the past year have supported it as well.

Even then, 802.11ac isn’t as simple as a tickbox: does your mobile device include a 2x2 wireless antenna configuration? Or 3x3? A combination of space limitations and price means this is a corner often cut by device manufacturers, so check exactly what you’re getting before you buy.

Finding out for sure isn’t simple, although there are clues: if a manufacturer says “supports MIMO”, then it almost certainly has a 2x2 antenna configuration.

(Don’t be fooled by the phrase “dual-band”, which simply means the device supports both 2.4GHz and 5GHz frequencies.)

As a rule of thumb, most premium tablets and phones will include a 2x2 setup; budget devices may well make do with a single antenna. Laptops are less predictable, so check the small print for clues. Prepare to be frustrated, though, as many manufacturers seem to deliberately



obfuscate this information. Anyone would think they had something to hide... and often they do.

And what of 3x3? For now, this is an incredibly rare sight in the wild. It’s limited to premium laptops such as the MacBook Pro 15in (pictured above), in part due to the fact 3x3 streaming works best when there’s a decent distance between the antennae. If you’re desperate for fast downloads, though, you can buy a 3x3 Wi-Fi adapter, as we used for our testing.

You might then wonder why our Labs winner is one step ahead of the current top-end phones, tablets and PCs: we’re still waiting for Wave 2, 4x4-stream 802.11ac and multi-user MIMO (MU-MIMO) to gain any sort of traction. Why go to the added expense of a router like the Netgear Nighthawk X4s?

Part of the reason, as ever, is to be ahead of the curve. This may be your router for the next three years, so why not spend an extra £50 and reap the benefits later? Besides, you’ll likely see the benefits of a router upgrade today, even without hardware that can reach the theoretical bandwidth limit. The results from this month’s tests show that 802.11n speeds can increase dramatically when you switch out your ISP-supplied router, and if that model didn’t have external antennas you could find swapping to one that does lets you access the internet from rooms in your house that were previously dead spots.

Any device you buy in future will benefit immediately from an upgraded router, so switching today should prepare your network for the devices and network adapters set to launch in 2016 – and beyond. ●

How we test

All the routers reviewed in this Labs were tested in a tightly controlled, real-world environment, letting us compare each one objectively with the minimum of interference from other wireless devices.

We first connected each router to a desktop PC via Gigabit Ethernet. The PC was fitted with an SSD to ensure it wouldn’t create a performance bottleneck. With the router and PC in one room, we set up a second PC with a 3x3-stream, 802.11ac Wi-Fi adapter 2.5m away within the same room to test close-range speeds.

We used the command-line utility *iperf3* to measure transfer speeds over 2.4GHz 802.11n and 5GHz 802.11ac connections, before repeating the tests at a distance of 15m with a brick wall in the path of the wireless signal. Because you’ll only approach the fastest speeds with an 802.11ac

adapter installed in your laptop, PC or tablet, we then repeated each test using a 2x2-stream, 802.11n iPad mini 2 to gauge how older hardware copes with the same signals.

Some of the routers on test have theoretically faster maximum wireless speeds than our reference equipment can reach, but since there aren’t any USB or PCI Express Wi-Fi adapters capable of matching them, these are mentioned in each review rather than on the results table.

Where the router supported it, we also tested direct file transfers via USB using a Verbatim external SSD; this USB 3 drive ensured the router would be the limiting factor in speed tests.

We’ve presented the results in the table opposite, which is colour-coded to help you track the performance of the router you’re most interested in.

The Network



Practical buying and strategic advice for IT managers and decision makers

Business Focus

Choosing the right remote support software **p94**

The Business Question

How can we recruit IT talent for the future? **p106**

Cheat Sheet

The dark and dangerous world of shadow IT **p108**

BUSINESS FOCUS

How to choose the right remote support software

Are you still heading to people's desks to solve problems, or stuck using free support software? **Dave Mitchell** helps you make the right choice

If you've ever tried to resolve a computer problem over the phone, you'll know how frustrating it can be. The person with the problem does their best to explain it, and you guide them through the process of resolving it with what seems like a 50/50 chance of success. Sometimes worse.

A site visit is often out of the question, and even if you work in a dedicated support department, you may be understaffed and too short on time to help in person. So, what's the answer? Remote support software – with which you can connect to the system, diagnose and fix it, all from the comfort of your own desk.

No two businesses have the same needs, but there's a huge range of support tools to choose from. This month, we review four solutions from some of the biggest names in the market, namely Bomgar, Netop, NetSupport and SolarWinds.

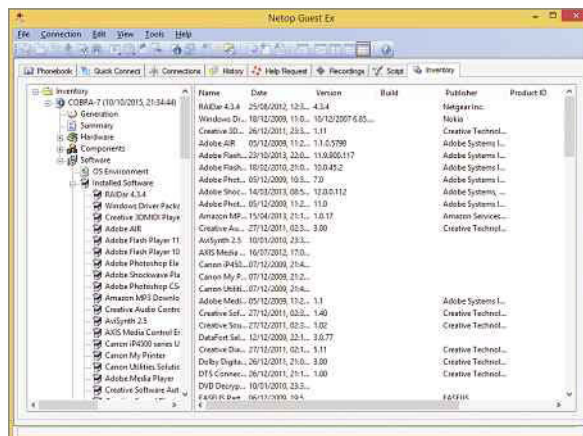
They take different approaches to providing remote support: one employs a cloud appliance, while the others use a central console to access remote systems. We've put them through their paces in the lab to help you understand which one best suits the remote storage needs of your business.

Access or support?

With a wealth of free remote access software available, it's tempting to cut costs and use one. However, they have drawbacks since many evolved from the consumer market and lack tight security, auditing, access permissions and other features.

Google's Chrome Remote Desktop is a case in point. It's free, but each system requires a Google account, must have the app installed and exchange a 12-digit PIN. It's easy to use, but lacks auditing and access controls for the remote system, plus it restricts you to simple remote control.

BELOW Netop's remote inventory is very useful because it shows support staff the installed software



Good remote support solutions provide simple access procedures, but go way beyond this basic remit. Alongside screen sharing and remote control, they provide file-transfer utilities, text or two-way audio chat services, Registry editors and controls for rebooting the remote system.

Some scan the remote system when you connect and provide a list of installed applications. Others collect this information and then store it for reporting and analysis. This aids the troubleshooting process, with support staff immediately understanding the hardware spec and what's installed on the user's PC.

Secret agents

Most remote support solutions require an agent to be deployed on the remote system, through which support staff can access and control the machine. Some, which may require the agent to be permanently installed, provide facilities to push this from a central console, making deployment simple.

If you need support for a large number of systems, look for those products with built-in deployment tools. NetSupport Manager is a good example, as its Deploy tool can be used to scan the network and silently

push the agent to selected systems. Its custom scripts then determine which support features will be available.

If you're unhappy having an agent permanently loaded, consider the products that provide an on-demand agent. This is loaded only at the start of the support session, and is removed upon completion.

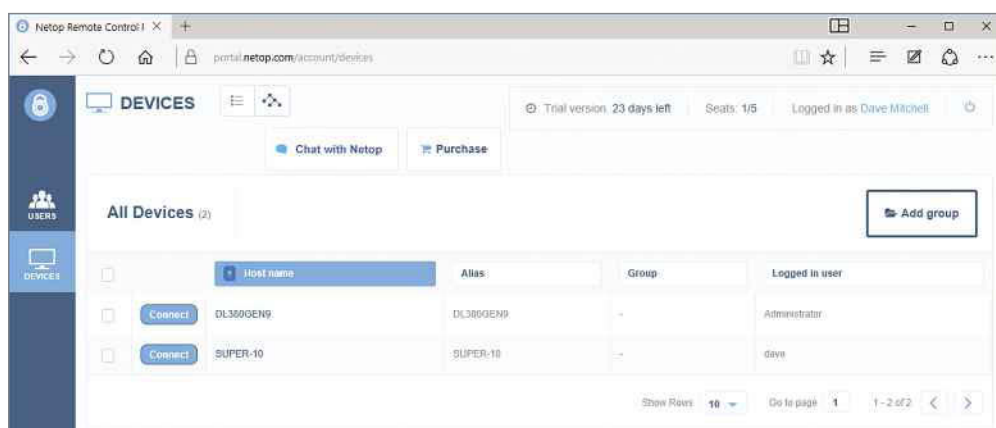
Look, but don't touch

Poorly configured remote-support solutions can leave a gaping hole in your network perimeter. In its 2015 "Global Security Report", Trustwave claimed 28% of the data breaches it investigated were caused by weak remote access security.

You need to make sure that only authorised staff can access systems. Security is a key consideration, and all of the products here have a range of features and authentication methods.

Network endpoints aren't the only security consideration, though: you may want to limit what your support staff can do. There's a huge difference between screen sharing and full remote control, so look for products that can restrict these functions and only allow specific people to use them.

Whether you want staff taking control of systems with sensitive or personal information is another issue: the implications may not be only a matter of trust but also compliance with data-protection regulations. All



four products can, therefore, limit what may be accessed.

Platform support

Windows is the prevalent desktop operating system in most businesses, and we had no problems connecting to Windows 7, 8, 8.1 and 10 workstations.

You may want OS X on the guest list but we found support for the latest version, El Capitan, to be patchy. The Bomgar and NetSupport OS X agents worked fine, and DameWare uses the built-in VNC Viewer, but Netop said support was still under development.

Most Linux distributions are supported, but you can't remotely control iOS devices such as iPads and iPhones: the use of private apps is in violation of Apple's terms and

ABOVE Netop's WebConnect 2 tool adds basic cloud-hosted remote control

conditions. However, you can use your iOS device as a mobile support desk. Bomgar, NetSupport and (to a lesser degree) Netop offer free apps that can be used to view, connect to and control remote systems.

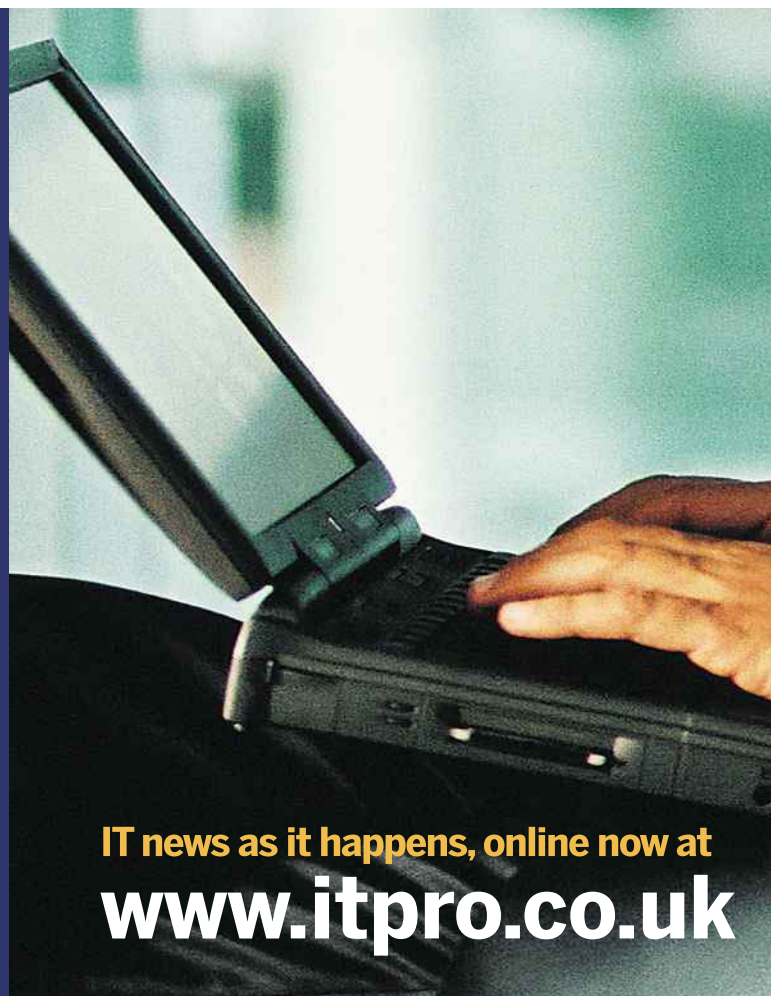
Accountability

If your support department has service-level agreements, you'll want to ensure your chosen product has auditing features that can log all calls, activities, chats and resolutions. Even better is the facility to record sessions.

The right remote support solution will benefit businesses and boost productivity. We do recommend some training, though, so that your users understand it's there to make their life easier, and not for you to spy on them. ➔

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Bomgar Cloud for Remote Support

Bomgar delivers an easily deployed, cloud-hosted support solution with watertight security

SCORE ★★★★★

PRICE From £1,395/yr exc VAT from bomgar.com

Bomgar could be the perfect choice if remote access security is your biggest worry. With physical, virtual or cloud appliance options, it's designed to provide businesses with a completely secure environment and unbeatable control over what staff are allowed to do.

We reviewed Bomgar Cloud for Remote Support, which allowed us to log in to our cloud-hosted VMware appliance through a dedicated URL. Once inside, we could create new users or "representatives" from its administrative interface. This made it immediately obvious just how security-focused Bomgar is.

The wide range of user controls let you specify what each member of a support department can and can't do during a session. Along with access restrictions to the appliance, we could also block access to specific end-user input devices, control file transfers, permit support staff to share their sessions with other representatives, and run presentations. The full list of features is enormous.

Session policies let you control which support tools are available during a session, and which prompts those receiving remote support



should see, such as requests to cede control of their machines. You can also define group policies for multiple representatives, which have hundreds of available settings and controls.

Every representative has their own, separate console app, and their login credentials determine what support features are available. The app is well designed and provides separate panes for viewing support requests and message queues, other group members, clients and systems.

Users needing assistance will send a request through a web portal, which places them in a queue. Depending on your security requirements, you can show a list of available representatives so that clicking on one initiates a download of the Bomgar Jump Client and opens an instant connection to that user's support console.

At the end of a session, the Jump Client is completely removed from the remote machine, but you can install it permanently if you want to maintain persistent connections to the support

ABOVE Secure remote sessions are run from the Bomgar console, which has plenty of useful tools



installed are displayed in the support portal, where support representatives can initiate a remote session by clicking them.

Policy settings control whether the remote user must permit the connection request, which can also be set for file transfer, screen sharing and full control. All remote connections are encrypted with 256-bit AES and the console loads a new tab for the remote system. This includes a screen view and access to other tools, including a command shell, Registry editor and power or reboot controls.

The console can have open connections to multiple systems, and we found swapping between them easy. Meanwhile, sessions can be recorded, transferred to other representatives or shared with them, and presentations can run to multiple users through screen sharing.

If permitted, users can end support sessions at any time simply by closing the client's message window. At this point Bomgar will present them with

a survey to gauge their satisfaction with the support session, which is a neat touch.

It took a while to get to grips with the myriad security policies but, once we were over this

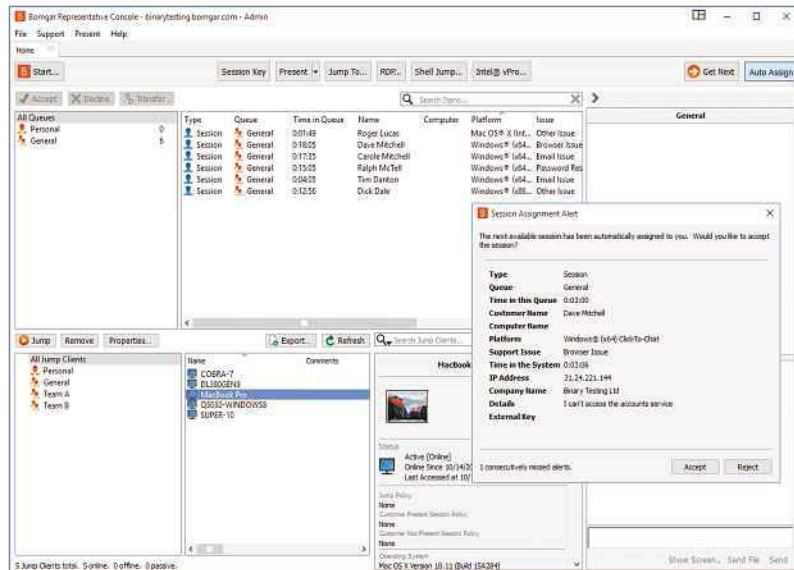
hurdle, we found that Bomgar Cloud for Remote Support was the best at putting teamwork into support services. It offers an amazing range of features for the price and should be a serious contender for those businesses where security is paramount.

"The wide range of user controls lets you specify what each member of a support department can do during a session"

LEFT The Bomgar Representative Console keeps track of all support requests and Jump Clients

REQUIREMENTS

Console/Client: Windows XP/2000 upwards
 ● OS X Snow Leopard (10.6) upwards ● Linux
 ● Blackberry OS 5 upwards ● Android 2.3+ upwards ● iOS 7 upwards



Netop Remote Control 12.2

Affordable remote support with handy cloud-hosted remote control and stiff security

SCORE ★★★★★

PRICE One guest/ten hosts, £625 exc VAT from netop.com

Businesses looking for a wide choice of client connection types will appreciate the options offered by Netop Remote Control. Along with guest and host components, it offers a cloud portal for remotely connecting to users' systems and – if you don't want to rely on a third party to host the support sessions – you can do it all yourself with the optional Netop WebConnect module.

It's also big on security. Access to hosts can be password-protected, and you can authenticate using Windows login credentials and integrate Netop with Active Directory. Netop also offers an optional Security Server module that both maintains a central log-server database and manages network authentication tasks.

Each remote PC must have a host component installed locally, which worked fine on our Windows desktops. However, this hadn't been updated to support OS X El Capitan at the time of



our tests. Larger deployments can be streamlined with Netop's Pack'n Deploy tool, which sends the host to multiple Windows systems, complete with custom configurations.

All of the Netop action takes place at the guest console, which hasn't changed a great deal in many years, other than a lick of paint. Even so, we found it easy to use, presenting a neat row of tabbed folders for each function. For example, we used the Quick Connect tab to browse the network and pull up a list of systems running the host software.

Connecting to a remote host is a simple double-click manoeuvre, while a dropdown menu provides quick access to functions including remote control, a file-transfer window, text chat and audio or video chat. The

ABOVE It's very basic, but Netop's iOS app can remotely control systems on which the host has been loaded

"The host component worked fine on Windows, but hadn't been updated to support OS X El Capitan at the time of our tests"

LEFT We could browse for available hosts and directly connect to them from the Guest console

or shared folders and directly control the host. We could even log out the remote user and restart the machine.

Netop's guest console accurately displays hardware and software inventories, and it correctly identified hardware including CPUs, memory and hard disks on our test systems. It also got all the OS versions right and provided a complete list of software

applications, along with their installation dates and version numbers.

We needed to enter a user's password every time we connected to their machine, but this can be streamlined using the guest's Netop phonebook. Each entry in the book contains authentication credentials, encryption options, keyboard and mouse behaviour and more, allowing host connections to be initiated immediately.

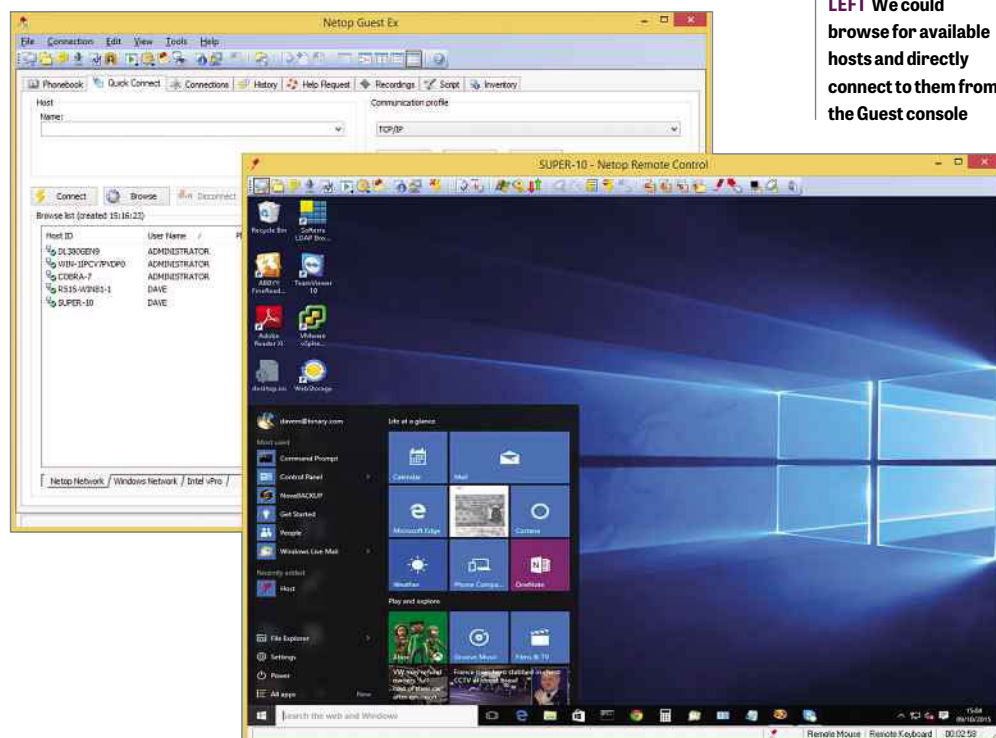
The WebConnect 2 portal required the host profiles to be reconfigured with the portal's web address, plus a username and password. It provides a list of available devices, which can each be placed into custom groups. Connecting to the remote host is then just a matter of entering a password.

The hosted service only allows for remote control, meaning the range of support features on offer is basic. We could lock, restart or shut down the host, resize the display to fit, and use the Windows key, but that was all.

Netop Remote Control is easy to deploy and use. It offers an impressive range of features for the price and is best suited to businesses that want swiftly deployed remote support that's tightly locked down against unauthorised use.

REQUIREMENTS

Netop Guest/Host: Windows XP/Server 2003 upwards • OS X up to 10.1 • Linux



NetSupport Manager 12.1

The remote support host with the most – it's easy to deploy and offers a great range of features

SCORE ★★★★★

PRICE 100-249 systems, £33 each exc VAT from netsupportmanager.com

NetSupport Manager (NSM) has one of the longest track records in the remote support market – and it shows. Its central console seamlessly integrates an unbeatable range of features, while a one-off fee means it's great value in the long term.

Pricing is based on the number of supported end points, with between one and 99 costing £40 each, which drops to £33 for between 100 and 249 systems. At its foundation, NSM provides centrally managed remote control, file transfer, text or two-way audio chat (with recording facilities), plus detailed hardware and software inventory. Furthermore, you receive NetSupport School at no extra charge. This provides monitored training sessions to classrooms.

Installation proved swift. We loaded the NSM Control component and then used the Deploy tool to scan the lab network and push the client to selected systems. Each installation took around a minute to complete and the utility allowed us to create silent installations, use different profiles for host groups and specify whether users could interact with the client.

We had no problems pushing the client to Windows 7, 8, 8.1 and 10



ABOVE NetSupport's Control console is a pleasure to use and its remote support tools are extensive



desktops, nor to a MacBook Pro running OS X El Capitan. A search tool made light work of adding them to the console, and NSM's dynamic grouping neatly sorted them into categories based on their operating system. We then created custom groups in the console and dragged and dropped selected clients into them for easier management. Selecting the Connect option from each client icon pulled up live thumbnails that showed what each one was up to.

Double-clicking a client icon opens a remote session or, if you prefer, you can also use a dropdown menu to passively view a remote screen, start a file-transfer session, have a chat or send a message. We used the viewing window, through which we could take screenshots, launch applications, share clipboards, reboot the client and, where supported, have an audio conversation using headsets.

"The iOS app allowed us to view all clients, initiate remote control sessions, chat, check their inventory and reboot them"

LEFT We used NetSupport's iOS app to remotely control a Windows 10 desktop



In theory, you can tell which country the client resides in using the Geo-Locate feature, which adds a small flag to the top-right corner of their icon. Hovering the mouse over the flag pops up a window with what appears to be the client's actual location. However, take into account that – because it used the termination point of our broadband connection – it was out by

around 60 miles in our tests.

More impressive was the NSM client, which gathers hardware and software inventories for each system and stores them on the Control host. It's very accurate, showing all of the hardware components for our selected clients, plus installed software, and which applications were running, as well as processes and services.

The NSM iOS app proved very handy. With this loaded onto an iPad, we could view all clients, initiate remote control sessions, chat, check their inventory, pull up a virtual keyboard and reboot them.

Client connections are secured using an NSM PIN server running on either the NSM Control or another system. Once installed, the client or controlling user can request a PIN, which establishes a connection when correctly entered on both sides.

We were impressed by the security offerings: clients can be password-

protected, the Gateway utility supports a range of encryption schemes and you can use Active Directory policies. NSM Control also lets you create different user profiles that determine

what support staff are allowed to access on remote systems.

NetSupport Manager is quite simply one of the best remote support tools on the market. It provides a superb range of tools, while including NetSupport's School software and the one-time cost per seat makes it excellent value.

REQUIREMENTS

Supports Windows XP SP3/Server 2003 upwards • OS X 10.5 upwards • Linux • Mobile Control app for iOS and Android

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SolarWinds DameWare Remote Support 12

Not the best designed central console, but it's affordable and easy to deploy

SCORE ★★★★★

PRICE For 4-5 technicians, £215 exc VAT each from dameware.com

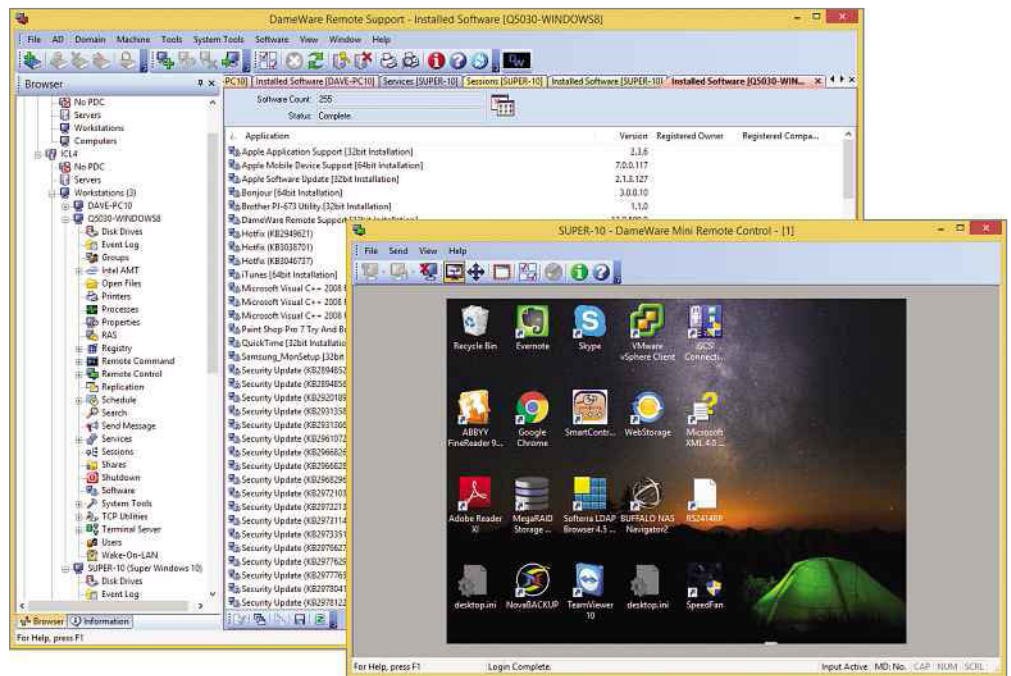
DameWare Remote Support is one of the few solutions that can do most of its work without an agent installed on each desktop. It integrates with Active Directory and provides plenty of tools for administering domain objects: containers, groups and users.

However, it does rely on an agent installed on the target system when using the Mini Remote Control utility, through which you can connect to a system from almost anywhere. This can be loaded only for the duration of the support session and, when you finish, it removes itself. Otherwise, basic remote control is achieved using Remote Desktop Protocol.

The Mini Remote Control utility can be accessed from the main Remote Support interface or loaded as a separate application. We found it easy to use for our Windows systems.

We tested the standalone version, but DameWare also offers a Central Server edition for larger, distributed businesses. Both are good value, with licensing based on the number of remote support technicians and not the systems being supported.

When first opened, the Remote Support console checks the network and presents a list of detected domains



and workgroups in a tree structure, which placed the servers and workstations on our test setup in separate, easy-to-access groups.

Selecting a system opens a complete overview of its hard disks, with graphs of free and used space, a table displaying more detail, and direct access to Windows' option to restore previous versions.

The console displays the selected system's event logs and running processes, and if the remote Registry service isn't running, it will start it for you. We could then remotely view and edit its Registry, and reboot or shut down the system.

We loaded a command-line prompt, event viewer and performance monitor for the remote system from the System Tools section. Rather annoyingly, every tool selected adds a quick-access tab at the top of the central window, which doesn't close down when you select another.

ABOVE The DameWare console can manage large networks, but could be easier to use

It's all too easy to end up with ten or 20 tabs loaded without realising it. And some of the options hint at DameWare's age, such as when it tries to load vintage apps such as NTBackup and the Windows NT User Manager.

DameWare doesn't perform an inventory on your remote systems and store the information, although it will scan each system's properties to show details of its CPU, memory, graphics and so on. We could also view all installed software, but each time this was selected, the console queried the remote system to pull in a list. This could then be exported as a CSV file.

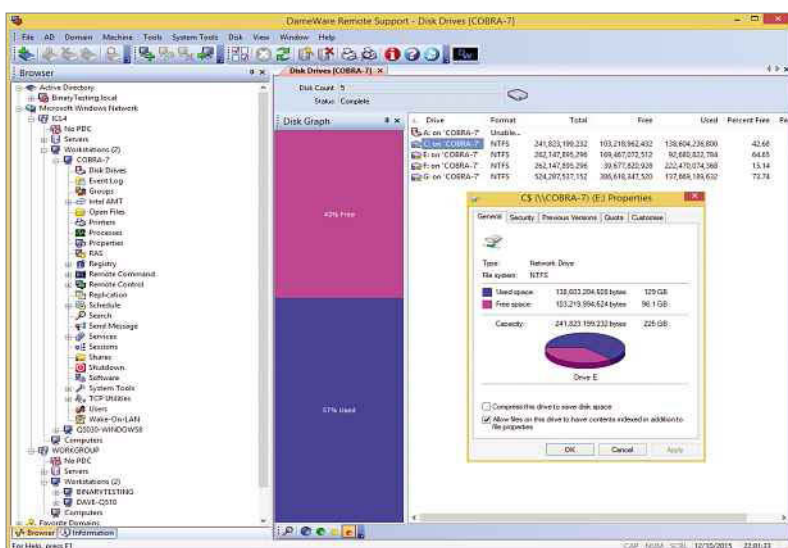
You'll only need to use the DameWare Remote Support Service agent to access a small number of features, including the remote command viewer and console, plus the system reboot and shutdown commands. When we selected these, DameWare offered to load the service on the target system for us.

"DameWare can connect to Macs using the VNC service and we had no problems with our MacBook Pro running OS X El Capitan"

DameWare can connect to Macs using the VNC service, and we had no problems with our MacBook Pro running OS X El Capitan. You'll need to edit its screen-sharing options to allow VNC viewers to connect to the system.

For large networks, the Remote Support console will look busy and it includes a few redundant tools. That said, its agentless architecture makes it easy to deploy, and basing prices on the number of technicians make it good value. **DAVE MITCHELL**

LEFT DameWare doesn't need an agent installed to give you information about a user's hard disks



REQUIREMENTS

- Console: Windows 7/Server 2008 upwards
- Clients: Windows Vista/Server 2008 upwards
- Linux and OS X (VNC enabled)

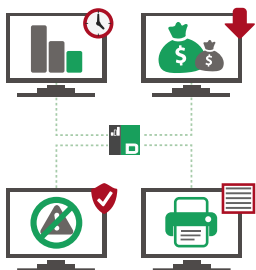
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Brother DCP-9015CDW

An affordable multifunction printer with excellent cloud support – but colour print speeds are slow

SCORE ★★★★★

PRICE £172 exc VAT from m4store.co.uk

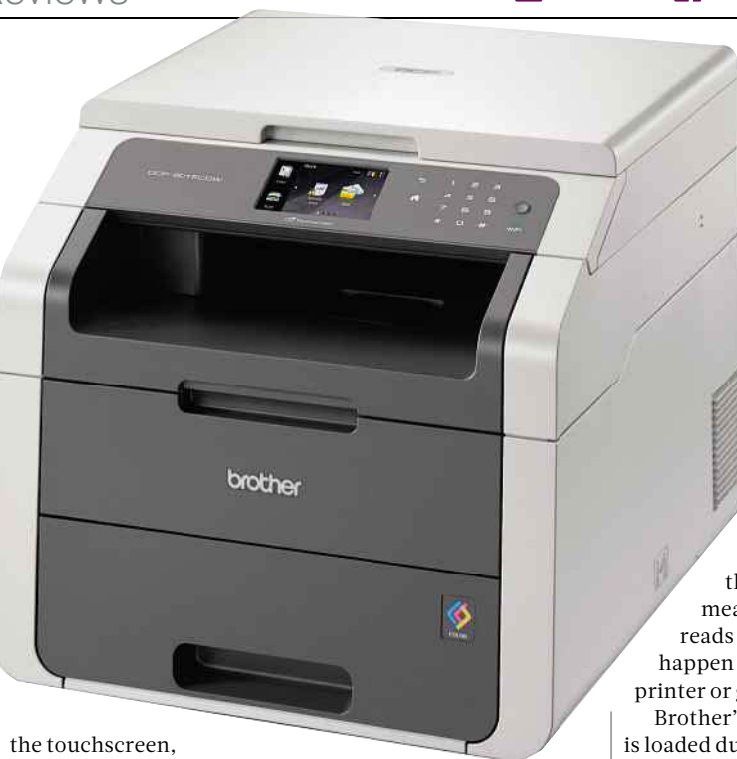
At less than £200, Brother's first wireless-only network all-in-one laser has plenty to offer the SMB looking for a colour multifunction printer (MFP).

Setup is a breeze, courtesy of a wizard and the 93mm colour touchscreen: we had it up and running on our lab's test network in less than a minute. It supports the AirStation One-Touch Secure System (AOSS) and WPS with PIN, while mobile devices can connect using AirPrint and Wi-Fi Direct.

The printer provides standard print, copy and scan functions (but not fax), with built-in duplexing. There's no automatic document feeder on the flatbed scanner, so you can only scan and copy single pages, and, although there's a USB port for connecting directly to your computer, it can't be used for scanning to or printing from memory sticks.

It ships with 1,000-page starter cartridges, but combining the costs of Brother's high-yield toner cartridges with the drum, transfer belt and waste bottle gives you a mono page price of 2.2p and colour for just under 10p, which are in line with other lasers in the sub-£200 price bracket.

Brother's Easy Scan to Email is self-explanatory: after registering and PIN-protecting our email addresses at



the touchscreen, we were scanning to email within a couple of minutes. We had the choice of dispatching JPEGs or PDFs, and Brother supports searchable PDFs and Office formats.

We could also scan directly to an FTP server and network folder. Cloud support is great, covering OneNote, OneDrive, Box, Google Drive, Dropbox, Facebook, Picasa and Flickr.

Registering with our cloud accounts through Brother's Web Connect portal was easy. Selecting the Web option on the touchscreen gave us direct PIN-protected access to our cloud services, where we could upload scans, browse remote folders, choose a file and print it out. We also used Brother's iPrint&Scan iOS app on an iPad to connect to our cloud services, print files and access the scanner to pull in documents.

Print management and security are both top notch. Controlled using

the printer's web admin console, they extend as far as setting page count limits for each user and specifying whether they could print using colour or just mono.

The printer driver can be used to secure print jobs by assigning them a PIN. This puts the job in the queue until authorised on the device itself. Our users could then walk up to the printer, select their name on the screen and enter their PIN to release the job, which is a simple means of ensuring nobody reads sensitive content if they happen to be standing at the printer or get there before you.

Brother's ControlCenter4 utility is loaded during the driver installation – along with a system tray status monitor and TWAIN driver – and is preconfigured to use the network scanner. It provides quick access for copying documents and scanning them to OCR, email and local files, while Nuance PaperPort handles OCR functions and offers handy document-management tools.

We only achieved the quoted print speed when printing in mono, with an 18-page Word document delivered in 60 seconds. Note that there was a delay of between 12 to 18 seconds before the first page appeared. Colour was more challenging: the frequent pauses while printing our 24-page DTP document reduced the average speed to only 7ppm.

“We used Brother's iOS app on an iPad to connect to our cloud services, print files and access the scanner to pull in documents”

Brother scored well in our office printing tests, with pin-sharp text and vibrant colour graphs and charts. Complex colour fades also transitioned smoothly through their

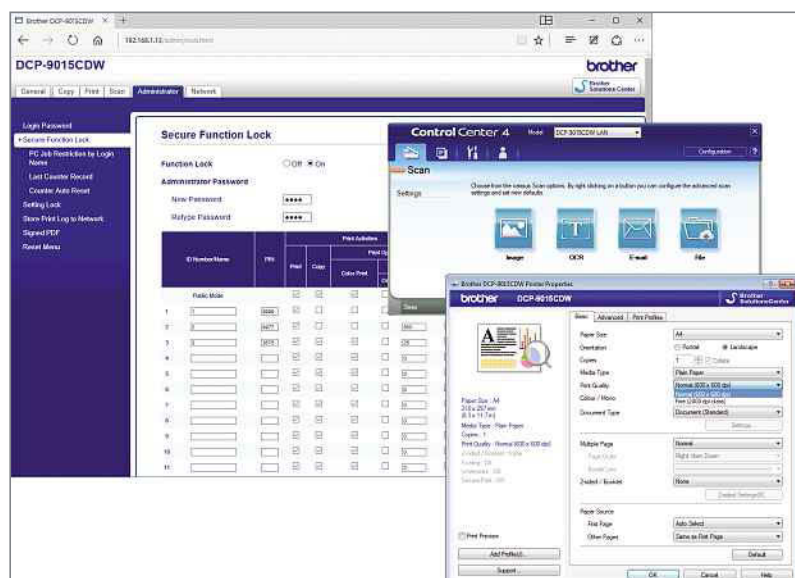
various tones. It's not so clever when printing mono and colour photos, though, as the characteristic cross-hatching produced by the LED printing technology is obvious.

The Brother is a good choice for small offices in need of centralised scan and print services. It's affordable and scores highly for security and cloud support. **DAVE MITCHELL**

SPECIFICATIONS

600dpi A4 colour LED, 2,400 x 1,200dpi colour scanner • 333MHz CPU • 192MB RAM • 18ppm colour/mono • USB 2 • 802.11n Wi-Fi • 250-sheet input tray • single-sheet manual feed • duplex • recommended maximum monthly cycle, 1,500 pages • 410 x 483 x 367mm (WDH) • ControlCenter4 • Nuance PaperPort 12 SE software • 1yr on-site warranty

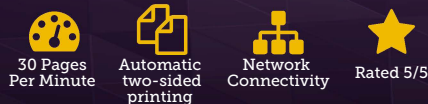
LEFT Restrictions can be applied from the web interface, and are backed up by plenty of desktop tools



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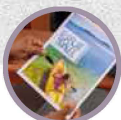
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RATED 4.9
OUT OF 5
by our customers





Thecus N8880U-10G

It may be short on features, but this rack NAS appliance combines 10GbE-readiness with excellent value

SCORE ★★★★★

PRICE Diskless, £1,399 exc VAT from lambda-tek.com

There are many reasons why storage-hungry SMBs will love Thecus' N8880U-10G, not least the uprated spec that gives this 2U rack NAS such a big performance boost. At this price, the inclusion of a 10GbE adapter makes it even more tempting.

Thecus' C10GTR single-port 10GBaseT card is bundled, saving you £158 exc VAT on the standalone price, while the drive itself has a pair of embedded Gigabit ports and dual 400W hotplug PSUs. Make no mistake: this is a very well-specified NAS device.

To reinforce this, Intel's 3.3GHz Core i3-2120 CPU sits in the driving seat, while the 8GB of DDR3 RAM can be expanded to 32GB. Eight hot-swap SATA drive bays lie waiting, but the lack of physical expansion ports means you can't increase this using extra disk shelves. However, the NAS stacking feature addresses external expansion capabilities in other ways, by making up to five iSCSI targets on other appliances available as network shares.

We tested the appliance with a quartet of 4TB WD Red drives, and used the Finder utility to discover it on our lab network. This provided direct access to its web console and quick-start wizard – which we opted to skip for two reasons.

First, it offered us a RAID6 array, while we prefer the higher capacity of a RAID5 setup. Second, it defaults to the EXT4 file system, but we wanted to use the newly supported Btrfs: this

brings in manual and scheduled snapshots for NAS folders and IP SAN targets.

Once it was up and running, the N8880U-10G certainly delivered the goods in our performance tests. With a direct 10GbE connection to an HP ProLiant DL380 Gen9 rack server running Windows Server 2012 R2, Iometer recorded raw sequential read and write speeds of 1,117MB/sec and 400MB/sec for a NAS share.

We saw similar real-world speeds, as our 25GB file-copy test returned sustained read and write results of 433MB/sec and 376MB/sec. It's no slouch for backup operations either, averaging a speed of 263MB/sec when copying a 22.4GB test folder containing 10,500 small files.

IP SAN performance was on the money too, with a 500GB iSCSI target delivering Iometer read and write speeds of 1,180MB/sec and 630MB/sec respectively. This is an improvement over the older N8810U-G, on which the NAS share read and write speeds topped out at speeds of 875MB/sec and 365MB/sec, while IP SAN speeds reached 1,040MB/sec and 450MB/sec.

Unfortunately, the appliance's web interface shows how far Thecus has to go to catch up with rivals such as Synology and Qnap. Compared to Qnap's latest QTS 4.2 firmware in particular, it looks and feels in dire need of an update and falls well short on features.

All the key storage utilities are present, with the Data Guard app handling scheduled backups of shares, folders and LUNs (logical unit numbers). It can back up to local storage, external USB devices and remote appliances, and has an extra option for sending data to Amazon S3 cloud storage. You can't back up to Microsoft's Azure

ABOVE The Thecus N8880U-10G has eight hot-swap drive bays behind its grille

or Amazon's Glacier, but Thecus does provide apps for syncing selected folders with Dropbox and ElephantDrive cloud accounts.

Thecus supports up to 16 snapshots for each NAS share or iSCSI LUN, which can be taken on demand or scheduled for daily, weekly or monthly intervals. Recovery was a cinch in our tests, where we deleted files from a share and used the web console's recovery feature to restore the entire folder from the latest snapshot in less than a minute. Impressive stuff.

NAS snapshots can also be made available to authorised users as network shares, allowing them to recover individual files and folders

"It's no slouch for backup operations, averaging a speed of 263MB/sec when copying a 22.4GB test folder with 10,500 small files"

using drag and drop in Windows Explorer. LUN snapshots are similarly simple to create and are restored directly from the web console.

Thecus is still undoubtedly playing catch-up with Synology and Qnap, at least as far as storage features are concerned. However, the N8880U-10G and its updated hardware package does put in a very good performance. SMBs that are after a basic 10GbE-enabled NAS and IP SAN storage appliance, but without the extra trimmings, won't get better value anywhere else. **DAVE MITCHELL**

SPECIFICATIONS

2U rack chassis • 3.3GHz Intel Core i3-2120 • 8GB DDR3 ECC RAM (max 32GB) • 8 x SATA LFF/SFF hot-swap drive bays • supports RAID 0, 1, 5, 6, 10, 50, 60, JBOD, hot-spare • 2 x Gigabit Ethernet • 10GBaseT PCI-E card • 2 x USB 3 • 6 x USB 2 • 2 x 400W hotplug PSUs • web-browser management • 3yr limited warranty

BELOW The drive has a pair of embedded Gigabit ports and dual 400W hotplug PSUs



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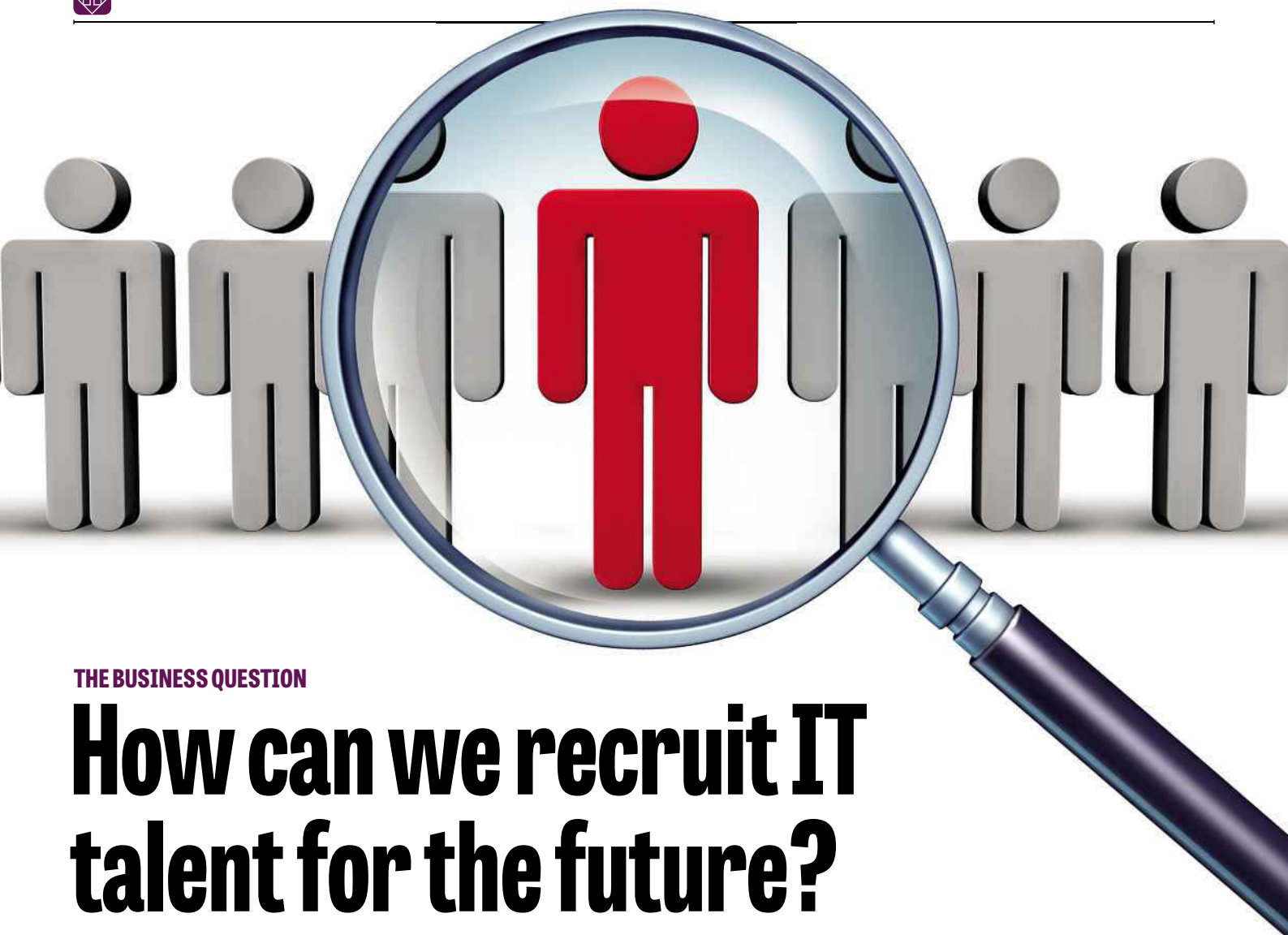
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THE BUSINESS QUESTION

How can we recruit IT talent for the future?

Technology comes and goes, but good employees stick around.

Nik Rawlinson discovers how to find the best IT talent

The workplace of 2005 was very different to the one we find today. Windows XP was still in the first flush of youth, a tablet was still something we swallowed, and with the iPhone still no more than a pip in Apple's eye, our phones had buttons, not apps.

Each of these technologies, as they appeared between then and the end of the decade, had a transformative effect on how we work, play and communicate, and opened up massive revenue streams for any tech-focused company that had the foresight to employ a workforce ready to embrace them. Rather than be blinded by what technical skills a potential employee has today – which may soon be out of date – consider how well they will cope with the shifting world of IT.

"The nature of IT [means] it's constantly evolving," says James Milligan, director of Hays IT. "What we're recruiting for now is different to what we'll be recruiting for in five

years' time and what we were recruiting for five years ago. If you want to be successful, you need to hire based on the type of person, not purely skillset, and then invest in those individuals."

Investing in employees' development – and demonstrating that investment to prospective candidates – are two parts of what Milligan sees as building a highly valued "employment brand", which would help a company attract the right employees to carry it forward. "There are more jobs than there are people, so if you're in a competitive situation the candidate holds the cards. You have to demonstrate why someone should even send in their CV for an interview with you."

Hays' own studies have revealed that, for the so-called Generation Y, personal on-the-job development and a clear career path are key draws that, all things being equal, will achieve the best response and see better levels of staff retention.

■ Train to work

Learndirect's Gavin Hubbard has similar thoughts on the correlation between training for the future and staff loyalty. "A good apprenticeship programme will lead to better staff retention," he said, "and those apprentices will go on and do more within those organisations."

"To be successful, you need to hire based on the type of person, not purely their skillset, and then invest in those individuals"

This is all very well for a bank, but what about smaller organisations, many of whom employ only a handful of staff and lack the resources to develop an equivalent training programme

themselves? Here, many would outsource the task to an organisation such as Hubbard's, which runs programmes for employers of all sizes, from multinationals to those with only half a dozen on the payroll.

"We try and look three to five years hence at what a business is trying to achieve," he explained. "[We'll] also look at learning trends to make sure

we're not designing a programme that's only got a year left in it. We'll always try and make sure we're designing a programme that's fitting [the employer's] strategy and isn't time-bound in any way."

Wherever possible, the training is delivered in a manner that suits Milligan's Generation Y workforce, and by remote means if that's practical. "We'll try and do WebEx, stuff that's mobile-compatible. It's all dependent on the capabilities of the employer and the employer's premises, of course, but we design the learning journey around that."

■ Location, location, location

Distance may not be an issue where training is concerned, but it's often a factor in the recruitment process, and any organisation that has the luxury of relocating or opening a branch office in centres of existing expertise can thrive. Rather than harming your chances, setting up close to your competition can pay dividends, since candidates of the appropriate calibre are likely to already be in situ. It's not always a case of relocating to the opposite side of the country, either.

"We've got a lot of information about future trends within specific sectors of industry and geographical areas," says Tom Laws of the National Careers Service. "It may be that, over the next five years, there's going to be a steep drop in demand for one particular role to be filled in one particular area, whereas on the other side of a county border it might be on the rise.

"Obviously, there are quite a lot of specific areas of the country that are dominant in the job market for

particular industries, so if a company is trying to set up in a geographical location that doesn't necessarily have a history [of that type of employment] in that area, they wouldn't necessarily be looking where the experience and talent pools really are."

It's a process that works both ways, though, and Laws believes that the candidates can employ similar tactics when searching for the perfect position. "Keeping up to date with professional bodies within the industry allows [them] to get a better idea with how trends are going, keep up to date with where new industries are being set up. If [they] get a head start on knowing there's going to be a technology-based company or industrial area opening in five or ten years, [they can] make sure [they] have experience to take advantage of the opportunities."

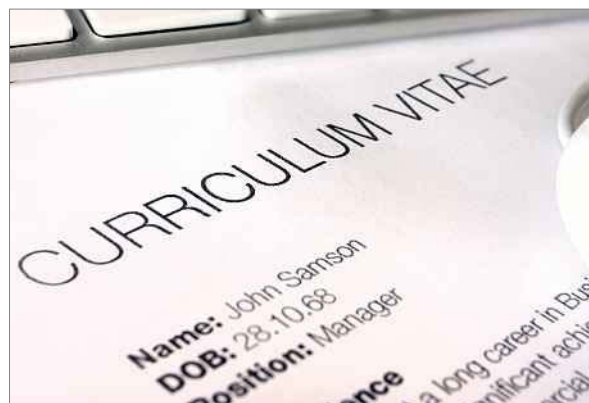
■ Looking to the future

The problem for employers is that the opportunities they can offer are often driven by external forces. Until Apple made changes to iOS and OS X, for example, they would have had no idea that they'd soon need to be hiring staff with experience in the Swift programming language.

Often, therefore, the flexibility of a candidate is more important than their existing skillset, and Hays' Milligan said employers with an eye on the future make hiring decisions based on a type of person rather than a specific ability.

"Employers recruiting for immediacy require a skill," he explained, whereas "the ones that are more strategic in their thinking hire on the basis of competence."

Competent, flexible staff, rather



ABOVE The flexibility of a candidate is often more important than their existing skillset

than those wedded to a specific discipline, will be the ones most likely to embrace external change. They're the ones with an enthusiasm for all that is new, a keenness to learn and an ability to bring evolving technologies into the organisation in an almost organic manner. So, how do you find such a person?

Generally, they're the ones who are as interested in what it's like to work for a company as they are in the remuneration, and with whom a conversation about the company's culture will help you to sell yourself as an employer.

"Competent, flexible staff, rather than those wedded to a specific discipline, will be the ones most likely to embrace external change"

"What you should be looking for is someone who is flexible in their post and has developed in previous roles [so] they can go in and learn and develop, and they have an

interest and passion," said Milligan.

"Candidates want to know what it's like working for a company, what are the prospects and opportunities, where is this company going? So it's the conversation about culture that's really important." ●



The expert view Steve Cassidy

The IT business has had what I consider to be a basic structural problem with recruitment. For decades, the dominant model (by which I mean the one that makes all the headlines) has been about trying to push the IT skillset as far outside the company as possible. "Get it done by a contractor," they cry – and have been doing since well before I joined the working population back in 1982.

For the first two years of my IT career, I was one of only six permanent staff in a 100-person IT department. Everybody else was a contractor. The rationale of the time was that technical progression – becoming more skilled and experienced – didn't line up with business progression, so techies were expected to hop around companies to pursue their careers. The fact that, for some, this fostered an attitude of

arrogant indifference to the business was assumed to be a sign of the nature of nerds, bless them.

When I get embroiled in a longer client relationship these days, it is normally (even now, 30 years on) trying to square the circle of that perception of an abusive relationship, with the reality of what soft, soppy humans get up to when brought together in a business team.

The indifferent nerd has been largely drawn in to the human side of businesses – especially, but not exclusively, in the small to medium business sectors. It has simply become impossible to function in business without both IT and someone who knows who to call and what to say when it all goes wrong. That trend has brought IT and IT workers out from behind the ivory tower of being just an overhead to be controlled by the financial director, and right forward to the marketing meetings, where their abilities can make the

difference between a great sales campaign and a total flop.

Perhaps the hardest part of this kind of engagement is helping the guy whose face just doesn't fit at that kind of meeting. Some people can be encouraged to change from an old-school mindset; others just won't do it, for reasons their boss can't figure out. This is when a change of employer – even of complete industry sector – is best for all concerned and can actually be achieved without acrimony, arbitration, industrial tribunals or heart palpitations.

This isn't to uphold the sitcom parody view of nerds, though. One of my most successful transplants was unhappy in the legal sector, and now works for a diamond company. It may be irrational of him to want large earth-moving equipment in his employ, but the last thing one should argue with in careers and HR is happiness.

Shadow IT

Davey Winder explores the shady world of hardware, software and services flying under a company's IT department radar



■ Shadow IT? Sounds dark and dangerous – what is it?

Shadow IT is a bit of a catch-all term that covers every piece of technology used within an organisation without the knowledge or approval of the IT department. It could be a smartphone, tablet, laptop, software application or even a cloud storage service being used by a member of staff to increase their personal productivity. It could also be, at the other extreme, an entire departmental-funded system that has somehow bypassed central IT awareness.

■ And what's it doing inside my organisation?

Truth be told, it's always been there, but not in great numbers. The cost and technical difficulty of merging your own devices into the work environment has meant it's traditionally been only something for uber-geeks. Until fairly recently, that is: costs have been driven down, and things have been simplified by technologies such as the cloud. As for what it's doing, well, it's there to increase productivity. Nobody is bringing in their own kit to make work tougher. These days, staff are more likely to just get on and use the tech they know will make life easier for them, without the hassle of asking the company to approve and buy it.

■ But isn't that a good thing?

Encouraging staff to be as productive as possible is, of course, a good thing as far as profitability is concerned. Taken at face value, there seems little harm in enabling employees to quickly deploy the technology they know, and often already have access to, without the hassle of corporate procurement procedures. However, the consumerisation of IT brings with it plenty of negatives, alongside the obvious productivity positives. Who is actually paying for it? If it's personal kit being brought in by staff, that might be seen as a win, but what if it's kit being signed off within a business unit? Who's to say that deal has added value to the organisation as a whole, rather than just buying the individual unit the ability to finish a job more quickly? Then there's the small matter of security.

■ Are you saying my smartphone is insecure?

Sort of. I'm saying that your smartphone, seen in the context of the organisational security policy it has bypassed, has the potential to bring insecurity into the business. The organisation will have a security posture, reinforced by policy, protocols and process, which is designed to mitigate risk. Sneaking in any technology under the

radar, out of reach of that mitigation, increases the risk. Mixing personal and corporate data, using public cloud services to move around unencrypted company data, and bypassing carefully considered security controls are never good ideas. If corporate security is bypassed, sensitive data breached and organisational reputations ruined, then all of a sudden the value equation that kickstarted this shadow IT usage doesn't look so great.

■ So shadow IT is dark and dangerous after all?

Yes, but it doesn't have to be. The solution to the problem is pretty simple: shine a light onto the tech and bring it out of the shadows. Mitigating the risk is key, and that means taking a more information-centric approach to security. Shadow IT is only "rogue" because you haven't officially embraced it, and your data is only at risk because you haven't properly secured it.

■ Okay, so just ban all unauthorised tech, right?

Wrong. Such policies are unlikely to work in the real world. If people are using shadow IT to increase productivity because policy is getting in the way, adding even more restrictive rules will only make matters worse. Instead, you should be looking at why people are taking the shadow IT route, and fixing the problems. Think about it this way:

"Find out which devices, platforms and services can be officially supported and then educate your staff as to the risks"

disruptive technologies only disrupt negatively when they are misunderstood. Embrace it rather than shadowboxing it, while also recognising the security issues. Just give thought as to how you can best merge governance and compliance with shadow IT use into a secure framework. Encourage an environment where you say yes, instead of no, with the caveat that it's a "yes you can do it safely like this" response.

■ That all sounds a bit "ideal world" to me...

Yes, it is, and the educate-and-embrace solution is not going to be for everyone. If regulatory compliance, or bloody-minded employees, prevent this approach, you need to find out what devices and services your staff are using and secure them accordingly. Investigate which devices, platforms and services can be officially supported, enforce the policy using security controls, and educate your staff as to the risks and the consequences of ignoring you. It's far better to adopt a middle ground, in which you discover what unauthorised tech is being used and why, then apply due diligence procedures to determine which can be used securely and block those that cannot. ●

The jargon

BYOD Bring Your Own Device refers to any personal device brought into the working environment without official authorisation.

Shadow IT This widens the remit to add applications and services to the BYOD mix.

Security posture This is the approach that your business takes to security and incorporates policy, process and protocol.

Endpoint management The discovery and control of the devices and services that request access to your corporate network.

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JON HONEYBALL

“You’ll know they’ve reached the end of the road when you see ‘upgrade to Windows 10 or we’ll kill this kitten’”

The news that Microsoft is going to be even more insistent in 2016 could leave a very sour taste in the mouth

Microsoft’s intention to aggressively push Windows 10 onto more of our machines leaves me with very mixed feelings. On the one hand, I genuinely can’t imagine why anyone with Windows 8/8.1 would want to stick with it when Windows 10 is so much better. However, I also agree that downloading a wodge of a Windows 10 install to people’s computers without asking is “courageous”, as Sir Humphrey would say. It’s neither Microsoft’s disk space nor its internet bandwidth that’s being spent (what if it’s over a cellular Wi-Fi dongle, or hotel Wi-Fi because you happen to be on holiday?). The news that Microsoft is going to be more insistent in 2016 could leave a very sour taste in the mouth.

On the other hand, I understand the problem. Microsoft is desperate, utterly desperate, to get users off Windows 7 and Windows 8 and onto 10. There’s no downside involved in this because it cuts costs, solidifies the customer base onto the latest platform, makes things easier for developers, and is a good PR story. Decide for yourself in what order those things are ranked in the mind of a Microsoft board director. So I’m caught between the same rock and hard place as Microsoft itself: push hard and take the flack (but gain the benefits) or be a gent and let things grind on.

Unfortunately, for many people, the move up to Windows 10 simply isn’t compelling enough. If Microsoft had bundled a free Office 365 Home licence with every Windows 10 upgrade, that would have really sweetened the deal, but whether it dares – given past Department of Justice investigations and monopoly abuse judgements – is entirely another matter.

What I think the company ought to do and what its lawyers will let it do could be two very different things. I don’t expect Microsoft to back down, however, as its entire strategy for operating systems (outside of the large commercial environment) revolves around the ability to get Windows 10 onto everyone’s device. Without that, there’s absolutely no hope of getting anyone to take Windows 10 Mobile seriously, and the tablet opportunities will continue to look feeble and be overshadowed by the massive sales of Android and iOS. So expect to see your router lights flickering soon. Expect Microsoft to bypass any “no, I don’t want you to download it” settings you might put in place. Expect the adverts to start flashing across your screen. You’ll know they’ve reached the end of the road when you see “upgrade to Windows 10 or we’ll kill this kitten”, and I wouldn’t be surprised if we get there eventually...



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“For many people, the move up to Windows 10 simply isn’t compelling enough”

Apple CPU

You might have been reading on various online hysteria farms (sorry, “news websites”) about problems with the iPhone 6s and 6s Plus processors. It appears Apple decided to use two different CPU foundries to make the core CPU for the new phones (TSMC and Samsung), that they differ slightly in physical size, and that the Samsung version uses what might arguably be termed a more bleeding-edge fabrication technology. I wrote about the issues of supplier component ramp-up in last month (see issue 255, p130), and since then I’ve been able to check this out for myself.

The problem came about because people have been running Geekbench’s battery test and discovering a significant difference in battery life that’s wholly correlated with the CPU fitted to your phone. Samsung devices appear not to last as long as TSMC ones. I’ve been doing my own tests on my 6s Plus and a friend’s model, which is identical to mine except that his has the Samsung chip while mine has the TSMC chip. There’s nothing you can see from the outside to tell which CPU is fitted, and you can dig as deep into the Settings panel as you like, but there’s nothing there – you need a small applet called Lirum Device Info Lite to tell which component is in your phone.

Now for the problem. I can replicate the issues as described with phones belonging to myself and my friend, but, at this point, we have to be very careful indeed. While a wholly synthetic benchmark designed to stress all the CPU cores, using a very tightly looping calculation, might be of interest to those who also collect engine numbers from the front of trains, it’s of very little relevance to anyone else. I ran both 6s Plus devices through a set of realistic end-user workloads, and by the time I got really bored, the charge remaining on one phone was 14%, and 15% on the other. Nothing to get excited about.

LEFT Microsoft is utterly desperate to move users onto Windows 10





Jon Honeyball

Opinion on Windows, Apple and everything in between – [p110](#)



Paul Ockenden

Unique insight into mobile and wireless tech – [p113](#)



Ivan Pope

3D printing offers fertile ground for business – [p116](#)



Davey Winder

Keeping small businesses safe since 1997 – [p118](#)



Steve Cassidy

The wider vision on cloud and infrastructure – [p120](#)



As I said last month, fabrication yield is a really big economic issue for a supplier the size of Apple, so dual-sourcing is imperative simply because no-one is big enough to supply the entire shipment. For myself, I'm entirely uninterested in the whole matter, having shown to my own satisfaction that there's nothing to worry about, at least this time around. Some other time, some other set of circumstances and the outcome might prove different. And my friend with the 6s Plus and its Samsung chip merely shrugs his shoulders and proclaims it to be the best phone he's ever owned. I'd have to agree with him, though some of the work being done in the Android world, especially by Samsung with its new screens, is truly breathtaking. It's hard to overlook, despite the limitations of the OS, infrastructure and application offerings.

Colour testing screens

Let's be clear, there's calibrated and uncalibrated. There's no middle ground. When it comes to screen performance and colour accuracy, setting by eye simply isn't good enough. It might get you close and work reasonably well, but there's still calibrated and uncalibrated. Doing it right involves measuring the performance of the screen itself, using a proper spectrophotometer tool and the right software.

The required hardware can range from the relatively inexpensive all the way to the sublimely expensive. There really isn't anything much better than the Klein K10-A – you point it at the screen and the device measures it within a fraction of second. It doesn't look at the whole screen, as you need only look at a small area measuring 43mm² in contact with the screen, 60mm² at 10cm and 75cm² at 4m from it. You can choose how close you want to be and how small the measurement spot becomes, and it will measure from 0.00006 to 10,000cd/m², which is

the darkest blackness you can image, to something so scorchingly bright it would make your eyeballs hurt. Peak white on an iPhone 6s Plus screen is around 570cd/m², so 10,000 is like looking straight into a floodlight.

Of course, the Klein K10-A is a precision instrument and its cost is astonishingly reasonable, if you need it. Last time I talked to Klein, it cost around \$7,000, which is perfectly fine

ABOVE The difference between the Samsung and TSMC processors is of little relevance to most people

BELOW Point the K10-A at a display and you'll know its colour accuracy in a fraction of a second



for a reference-grade measurement tool for a laboratory.

Back in the real world, though, the X-Rite i1Display 2 kit is a more likely choice. It comes in various flavours, but a full-house kit that can do screens, print-outs, projectors and more costs around £1,300, and then there are cheaper devices for a few hundred pounds. I'm not sure I'd trust a spectrophotometer that came with a two-digit price tag, to be honest. I have an i1Pro 2 (and the previous i1Pro model too) and it's a great piece of kit.

For measuring screens, the best software comes from SpectraCal, whose CalMAN software is the benchmark against which others are measured. It might surprise you that the basic CalMAN ColorChecker software ([pcpro.link/256calman](#)) is free. In less than five minutes, you can measure over 300 colour points and pattern changes, and then it will tell you what's happening with your screen. Creating a correction ICC profile does cost money, but, at \$199, it's really not much when you consider the cost of wasting photo-paper prints, or of making a colour decision that's just plain wrong in, say, the fashion biz. ColorChecker scales up through various versions to the big daddy, the Studio product that does just about everything you could want from a desktop computer, including writing out the colour-calibration files directly into the memory of colour-calibrated monitors from companies such as Eizo. It was the work of just ten minutes to run the software and measure my Eizo 30in reference monitor using the i1Pro 2 device,

then to inject the calibration values directly into the monitor's memory.

For me, the \$2,995 I paid for the Ultimate version has paid for itself many times over – this "everything including the kitchen sink" version is for serious professionals, and you can even calibrate multi-panel display walls with it if you want. You can calibrate all of the devices in your office too, which is critically important if you're moving photos from one device to another. It comes with ten desktop client licences,

and you'll need to run its software widget on each target computer to display the patterns, but they only cost \$49 per device once you've used the allocated ten licences. It's interesting that SpectraCal also offers iOS and Android widgets for free, so measuring your iPhone 6s Plus' screen is a snap and the results are very good indeed. No-one should have any problems with the colour accuracy of a standard iPhone 6s or 6s Plus, as it's as good or better than many of the high-end monitors out there. And I'm very much looking forward to measuring the forthcoming iPad Pro.

So colour accuracy is either right or wrong, with no grey area between (geeky joke opportunity missed there). SpectraCal CalMAN is the place to go for the best calibration software and the i1Pro 2 is worth its weight in gold, but I can see a purchase of a Klein K10-A in the near future. Why? The i1Pro 2 requires its sensor head to be in direct contact with the screen if used against a computer screen (it's different for a video projector), but I'd like to be able to take off-axis measurements to see how well the picture quality drops off when you turn a screen vertically and horizontally. Some tablets and smartphones have truly terrible off-axis performance, and it would be nice to know just how bad they were from a measurement perspective. For that, the Klein is the best. But please keep an appropriate sense of perspective – the SpectraCal software, and its bundling of the cheap SpectraCal C3 colorimeter for only \$149, is a great place for an enthusiast to start.

Apple keyboard and trackpad

I bought Apple's new keyboard and trackpad, and boy am I disappointed. Let's start with the keyboard. It's horrible (which is odd because I quite liked the keyboard on the MacBook). It has tiny vertical movement, but that somehow feels appropriate for a device that's only as thick as a sheet of paper and can almost be put in a large coat pocket. When used with a 27in desktop monitor and a huge multi-core Mac Pro, it's somewhat pathetic and just feels like a toy. I'll confess I used it for about 30 minutes and then put it to one side, never to be returned.

The new Apple trackpad is more interesting, although I find the whole Force Touch thing hard to get on with for a desktop. I don't mind it at all, indeed I quite like it, on my 6s Plus where it makes sense, but on a trackpad for a desktop computer it just felt odd. And the whole "click and then click through yet again" gave me a headache. I've turned off Force Touch, and the product feels the better for it.

Meanwhile, I've also bought Logitech's Bluetooth Easy-Switch Keyboard. Now this is clever: it can pair with up to three devices and you switch between them with simple key presses. It has a nice action, feels solid and is usable in every way that the new Apple keyboard isn't. It gets my vote for any application that needs a compact Bluetooth keyboard.

More hardware and upgrades

Firstly, a shout-out to the wizards down in Salisbury at Naim Audio. I've written about my delight at Naim

"We need to have the ability to do far more aggressive pre-caching of data feeds in the UK"

BELOW The Logitech Bluetooth Easy Switch Keyboard has a nice action and feels solid

Audio's Mu-so network streaming speaker system before. It's an absolute beauty. It's head and shoulders above anything comparable, and so completely dominates the field that all else is gaslight. A special pat on the back goes to the software-development team: keeping software bug-fixed and also investing the time to add new features, across Windows, Android and iOS, isn't easy for a small team. But they're doing a sterling job. Most importantly, they listen to feedback and then implement changes.

The latest upgrade allows the Mu-so to stream very high-quality (CD-quality) streams from the Tidal music service. I have to say I'm very impressed with this, especially as it has an offline feature on the iPhone client. The quality of the mastering seems very good, and the performance through the Mu-so is truly excellent. App integration is also spot on, so full marks to Naim for its development work.

I wish I could say the same for Apple's vaunted Beats 1 service. I listen to background music via a Bluetooth link between my phone and motorbike helmet on long journeys, and it's fascinating to hear just how badly UK 3G and 4G networks cope with the sort of continuous streaming demanded by Beats 1. Using an unlimited 4G SIM from Vodafone in my iPhone 6s Plus, I can't keep reliable streaming working outside of the M25. Even major roads like the A1 and M6 appear to have coverage so poor that the stream keeps dropping out. I'm very disappointed by this because what clearly works well in London – and doubtless works just as well in Seattle and Silicon Valley – doesn't hold up well hereabouts. We need

to have the ability to do far more aggressive pre-caching of these data feeds to allow for interruptions that could last for minutes at a time. Real-time streaming is a fallacy, as there are very few occasions when a truly real-time connection is required – listening to a live sporting event is one of the rare exceptions to the rule. News, entertainment and other general programming, for example, don't need to be absolutely synchronous.



Ham radio

Just a small note to follow up on a piece I did about ham radio several columns ago (see issue 250, p130). I have now received my licence authorisation back from the relevant government department, and can now operate as G1LMS once again after a break of some 30 years. It was rather touching to read the editorial from the head of the Radio Society of Great Britain, referring to my *PC Pro* column and how much they were looking



forward to my return to the airwaves (see pcpro.link/256rsgb).

I've splurged out the remarkable sum of £20 for the Chinese-built Baofeng UV-5R handheld 2m and 70cm walkie talkie, and have made contact with some of the local hams through the Huntingdon repeater GB3OV on 433.125MHz. Paying £20 for this facility is utterly ridiculous, and it clearly shows that amateur radio is no longer an expensive hobby. Given the knowledge level required to get through the licence exams, this is a hobby I can recommend to any teen who has a technical interest, and for any parent who despairs of the hours spent by an offspring on an Xbox or PlayStation shooting "enemy combatants".

Now my interest is becoming piqued by over-the-air digital data. It looks as though you can tunnel data over the internet between repeaters, and hook up an Android phone or tablet to your transceiver to perform slow-scan picture and data transmissions. This sounds like fun. I feel an impending somewhat larger shopping accident in my near future to see how much of this really works.

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PAUL OCKENDEN

"Once limited to the underwater lairs of Bond villains, home automation is going mainstream"

Choosing a home-automation system can be confusing, but it doesn't have to be difficult – or expensive

Once limited to the underwater lairs of Bond villains and clumsy demos on *Tomorrow's World*, home automation is at the tipping point of going mainstream. I predict that, in a year or two, it will be a booming growth area.

Let's take a look at the state of home-automation technology, bearing in mind that many of the products and techniques can be as useful in SME as home environments. It's a topic that normally generates lots of feedback when I mention it, so I'm guessing there's a fair bit of interest, but if you're just starting out you might be finding the numerous options perplexing.

For example, you'll find numerous standards on offer – LightwaveRF, Z-Wave, X10 and more – each supported by various manufacturers. On top of these, there are many proprietary versions from manufacturers. Then, just when you thought it couldn't get any more confusing, there are the offerings from big players such as Samsung (SmartThings) and Apple (HomeKit), that have recently entered the automation space. The options available are simply too bewildering, so it's no surprise many people walk away. My advice is this: decide what you need to do, then find a reliable, easy-to-use but low-cost way to achieve it. Ignore the standards and find something that works, so that when something better appears in two years' time it won't cause you too many tears should you decide to upgrade.



Paul owns an agency that helps businesses exploit the web, from sales to marketing and everything in between

 @PaulOckenden

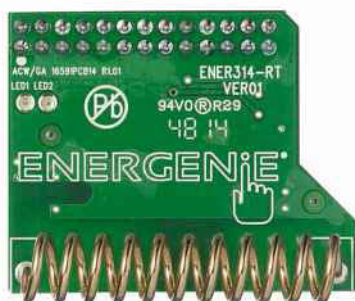
I've recently been playing with some devices made by Energenie. Unlike some of the kit I write about in this column, they weren't sent to me by a PR agency hoping for a few column inches: they're products I went out and bought out of my own pocket. You'll find many companies selling remote-controlled mains plugs, which enable you to plug in lamps or other appliances via adapters and supply an RF remote control to switch these appliances on and off. Energenie was a purveyor of just this kind of device a couple of years ago, but it has continued to innovate, creating products such as a four-socket extension lead in which each socket can be switched individually.

The real masterstroke came when the company started opening up its system to external controllers. Initially, this took the form of a small circuit board called the Pi-mote, which, as you might guess from its name, is an add-on for the Raspberry Pi. This allowed you to switch sockets on or off using simple scripts, which is where you may start to see possible applications for small businesses.

Imagine you have a temperamental broadband router that works most of the time but locks up once a month and can only be fixed by cycling the power.

Imagine, also, that your ISP won't let you swap this router for an alternative model. The solution? Plug the flaky router into the mains via an Energenie power adapter, then place inside your network a Pi-mote-equipped Raspberry Pi that's set to ping an external site every few minutes. If these pings fail, say, twice in succession (to allow for external glitches), run a simple command to power down the router, wait a few seconds then power it up again. This setup would cost less than £50, plus perhaps an hour's worth of time to get it all configured.

BELOW Energenie's power adapter can be used with a Raspberry Pi to mend dodgy Wi-Fi



With a bit of imagination, you can see how something like this might form the basis of a simple home-automation system. You might turn lights on at certain times of the day, for example, or use a few simple calculations to turn them on at local sunset rather than a fixed time.

However, with only simple sockets and one-way communication from a Raspberry Pi daughterboard, your options quickly become limited. You can expand them a bit by using a couple of product updates: an RT version of the Pi-mote board that performs two-way communication, and an updated socket that measures voltage, power (apparent and reactive) and frequency.

This arrangement means you can switch a heater on and off, say, but also detect and respond to the warmth of the room. You could also detect whether your TV is switched on, and adjust your audiovisual system or Velux blinds accordingly. In an office environment, you might only turn on your wireless printer/scanner if your PC is also switched on.

This still doesn't overcome all the limitations, though – there's no way to interact with the system remotely, which is what you need for a proper automation system. Enter Energenie, which has recently refreshed some of its older products by adding brilliant new facilities and packaging them under the sub-brand MiHome. (Actually, it's called "MiHome", but *PC Pro*'s house style doesn't allow for such branding frippery.)

The MiHome system includes all the bits I've just described – remote-controlled sockets, one-way and two-way Pi-motes, and monitoring – but it also adds many more abilities.

At the heart of a MiHome installation is a gateway box that connects to your broadband router and talks to the various MiHome devices scattered around your home or office. This gateway communicates with an Energenie-operated cloud infrastructure, which includes a web interface that you can use to control your devices from wherever you happen to be, and to view stuff such as historic energy consumption. There are also apps available for both iOS and Android devices. Alongside the various plug-in adapters, the

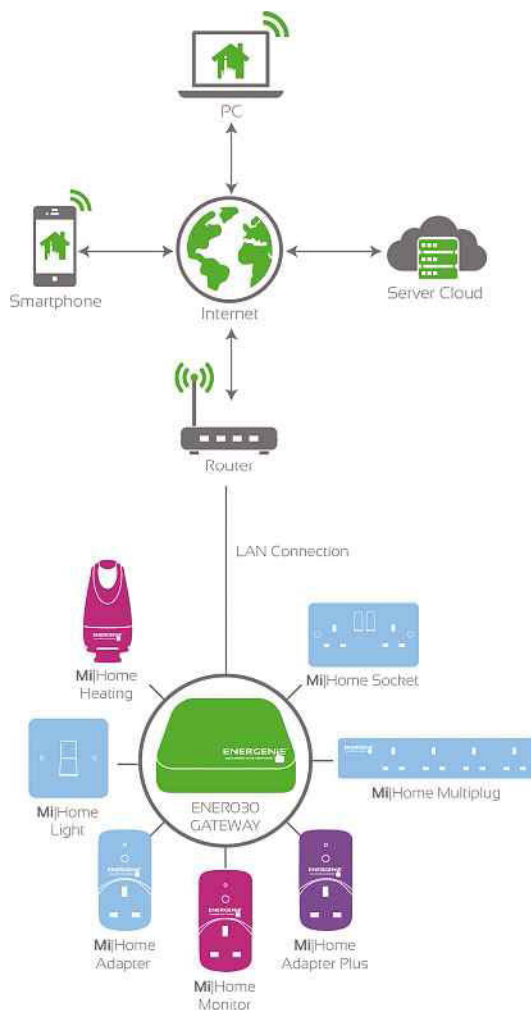
range of sensors and controls has been expanded to include the likes of current clamps that monitor your whole-house consumption, light switches, wall sockets, relays for other devices and even radiator valves – meaning you could use it to build a poor man's Evohome system.

You can pair new devices with your system using the mobile apps or the website. Either way, the wizard-like walkthrough makes it really easy, so you don't need to be a techie. The mobile apps also include a geofencing facility so you can, for example, turn on your driveway lights as you approach your house, or make sure the TV is switched off when you leave the room. If you work from a small office, you could use this facility to switch the kettle on just before you arrive.

It works very well. My only complaint is that the whole-house sensor is a bit dumb. It has only one current clamp, so it can't cope with extra power sources such as solar panels. If you happen to be exporting 4kW to the national grid, the MiHome sensor will think

ABOVE MiHome is a cloud-based home-automation ecosystem

BELOW The MiHome app is both feature-rich and easy to use – a rare treat



you're actually consuming that much, since it can't differentiate between import and export. It also assumes a standard power factor, which can be a problem at night when your main loads are probably eco-friendly lighting and electronic devices. All such devices present reactive loads with crazy power factors in which voltage, current and voltage load are, to a large extent, out of phase.

This can really confuse simple current clamp meters, but there are other devices on the market that get around this problem using plugin AC transformers (OpenEnergyMonitor) or foil-based voltage sensors (Eco Eye). Combined with a second current clamp to handle microgeneration, it would make for a far more usable product, but other than that I've been very impressed with MiHome.

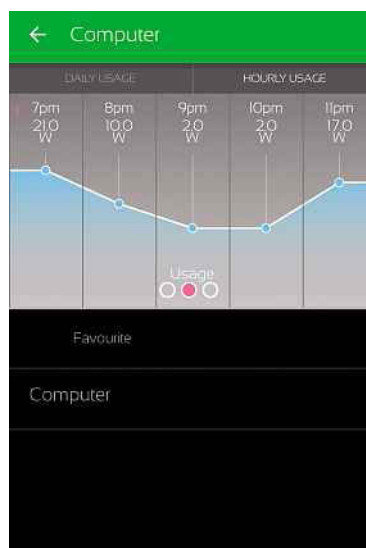
What really brings it to life is the fact Energenie has connected its cloud infrastructure to IFTTT, which you may remember I wrote about last month (see *issue 255, p113*). At the time of writing, the integration only offers actions, not triggers, but the folks at Energenie assure me that these are coming soon.

Even without triggers, you can do things such as turn on lights at sunset (similar to the Raspberry Pi example), or turn on a heater when it gets cold outside. You can even use your other home-automation products as triggers, to power down items in your home whenever your smart thermostat is in "Away" mode, for example.

This makes for a lot of flexibility, but you can go further still, because Energenie has published an API that you can use to monitor and control your devices. You'll find the details at pcpro.link/256mihome. Since it

uses simple JSON-formatted requests and responses, you can easily interface to it from almost any programming language. I've written some simple test scripts to turn sockets on and off, and, despite everything going via the cloud infrastructure, the processing delay and transmission latency is admirably short – actions seem to happen almost instantaneously.

I'm really impressed with MiHome – it's a well-thought-out ecosystem, and I'm sure it will only get better over time. The fact Energenie has made



the API and IFTTT available shows that it understands the kinds of things people want to do with home automation, and even without them the mobile apps and website are well considered and attractive – something that’s often missing in competitor products.

MiHome doesn’t employ Z-Wave or LightwaveRF, so it’s essentially a single-vendor solution, but this has pros and cons. It means everything works well together, and that it has a more professional feel than many alternative products. It’s also relatively inexpensive, so it’s not as though you need to worry about a huge investment going down the pan should Energenie go bust. Even if it did and its cloud infrastructure went offline, you’d still be able to use the remote control and Raspberry Pi boards.

You’d better watch out

Regular readers may have noticed that I hardly ever mention smartwatches in this column, and they might be wondering why. Those who know me personally might be more baffled still, because for years I was known as something of a wristwatch fan, collecting various timepieces, old and new, from some of the big-name brands. You can’t beat a nice movement. Smartwatches, though? Meh...

In fact, even before the advent of the smartwatch, I’d pretty well stopped wearing watches and my expensive timepieces had either been consigned to a bank vault or sold. I’d realised that everywhere I looked there was a clock: on the wall, in the corner of my computer screen, on my phone, on my cooker, on my microwave, on the radio. If everywhere I look there’s a clock, why wear one on my wrist?

It’s also quite liberating to go without a watch, since it’s all too easy to become a slave to time and find yourself checking every few minutes. Sure, you need to get to appointments on time, but your various electronic gadgets take care of that – your phone will probably even alert you when it’s time to leave, taking traffic conditions into account. A traditional wristwatch can’t do that.

Then along came smartwatches and I could – sort of – see their point,



especially since they were nothing new to me. Twelve years ago, I bought myself a Fossil Wrist PDA, which was a device massively ahead of its time. It ran Palm OS (remember that?) and was essentially what it says on the tin – a PDA on your wrist.

Back in 2003, there was no way to get permanent internet connectivity on a watch, which meant no alerts for incoming messages, but it would remind you of any appointments and allowed you to look up phone numbers. You could even take notes on it using the Graffiti handwriting system.

Mine mostly stayed in its box, though, and remains pretty well unused. Why? Because, although in PDA mode the watch could last a week or two on a single charge, as soon as you switched it to permanently display a watch face its battery would be dead within a day or two. For me, that’s just not acceptable. I wouldn’t wear a wristwatch with a power reserve of one day, so why would I tolerate it in a “Wrist PDA”?

This remains one of my biggest gripes about most smartwatches. It’s bad enough I have to make sure my phone is topped up, and I simply don’t want another device that I have to worry about charging all the time.

There are other things that bug me about many smartwatches, too. Let’s start with their size and weight. I know big watches are currently in fashion, but some of these devices are monsters. It’s not so much the diameter that bothers me (although they can look silly on my skinny wrist); it’s more their thickness. I’ve received a few sent to test over the years, and I’m always bashing them because they stick out so far. In fact, I was rather embarrassed by the condition of one well-known brand’s device by the time I sent it back to its PR keeper.

I also think many of them are plain ugly, as typified by the Pebble Time, in particular the round version. Take

ABOVE Is the Vector Watch’s combination of 30-day battery life and nice looks too good to be true?

“The real benefit of a smartwatch is the notifications it provides as an extension of my phone”

a look at the big, fat bezel – how could anyone find that attractive?

Incidentally, I think I know why that bezel is there. If you draw a square box around the round face you’ll find that it fits exactly inside that bezel, so I wouldn’t be surprised if there’s a square display under there and the bezel is just a facade to make the face appear round. I could be wrong, but once you see how well the box fits it’s hard to ignore.

Having said all of these negative things, I must admit I now see the point of the smartwatch – and it’s not for telling the time. It’s not even about apps. I really don’t need to control music or navigate maps from my wrist – these are things I prefer to do on the bigger screen of my phone. No, for me, the real benefit of a smartwatch is the notifications it provides as an extension of my phone, vibrating gently and flashing a message on its screen whenever I get an important message.

I suppose it’s all about being lazy, but a glance at the watch tells me whether I need to take the phone from my pocket or not. If only I could find a smartwatch that wasn’t pig-ugly and didn’t need to be recharged every night...

You can probably guess where this is leading: I think I may well have found just such a device. For a few weeks now, I’ve been testing a Vector Watch. This has an astonishing battery life of 30 days (and that’s not just marketing guff; it really seems to be a genuine figure) and it’s a thing of beauty. It comes in oblong and round versions – yes, the round one has a bezel, but it’s nothing like the monstrosity on the Pebble.

The watch, which appears to be manufactured by a Romanian company (although its marketing is very “London” indeed), works in conjunction with a standalone app that runs on iOS or Android. It doesn’t use Apple or Google’s existing smartwatch systems, but rather employs a Bluetooth LE link between phone and watch to push notifications and data streams such as weather or stock reports. It offers downloadable and stylish faces.

It’s early days yet, and I’ll report back when I’ve had the watch for another month or two, but things look promising. It’s quite simple compared to other smartwatches, but that’s part of why I like it. I think this is the first smartwatch that I might actually be able to live with.

 @PaulOckenden

IVAN POPE

“Discovering machines that could output digital files in real material was a revelatory moment”

The growth of 3D printing offers fertile ground for business. Here's how one man turned a hobby into a business idea

Like so many technologies that seem to arrive suddenly in public view, both 3D printing and 3D scanning have long and rich histories. The internet itself was over 30 years old when, in the early 1990s, the World Wide Web suddenly and forcefully brought it to the attention of a global audience. A complex history of development and research was ignored as the web seemed to arrive fully formed on day one, bringing with it thousands of business opportunities.

We have recently seen the arrival of 3D printing in the public consciousness, as a combination of patent expiry, commercial opportunity and public domain development efforts have brought an exciting technology to the mass market. Following close behind comes a technology that I find even more exciting: 3D scanning. What, I wondered, could the business opportunity be here?

I came to 3D printing about five years ago. I was looking around for something interesting to do and, as I started my life as an artist, physical objects retain a great interest to me. Discovering that machines could output digital files in real material was a revelatory moment. It was almost as exciting as discovering the global networks over 25 years previously.

It was the RepRap project (reprap.org), developed by Dr Adrian Bowyer at the University of Bath, that brought these machines into the world. Taking the view that a 3D printer should be capable of producing parts for another 3D printer, Dr Bowyer kickstarted a revolution. Using a technology for which patents had recently expired, and an approach founded on open-source philosophy, the concept of building your own 3D printer quickly



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“There was a variety of public domain software available, but none of it was very friendly”

went from idea to reality: small businesses producing the printed parts, kits and software morphed into dynamic commercial enterprises such as MakerBot and Ultimaker.

A French-made frog

By the time I realised that something exciting was happening, the industry was up and running. The first printer I got was a French-made Leapfrog, a state-of-the-art monster that was delivered in a wooden crate that we had to unscrew. This printer used fused deposition modelling (FDM). In other words, it took reels of plastic filament, melted them and squeezed them out like hot toothpaste until it built up the desired model in 3D. Although sold as ready to print “out of the box”, I soon discovered that there are many variables to 3D printing and that it's really not an out-of-the-box experience. I came face to face with 3D-printing software for the first time.

At the time, although there was a variety of public domain printer software available, none of it was particularly friendly. Again, I was reminded of my early internet experiences, where the complexity of actually getting online could make a

grown man weep. I persevered with the Leapfrog, all the while looking around at the growing industry and wondering what the business opportunity could be. I kept hearing that 3D printing was a “solution looking for a problem”, but it didn't put me off. I decided to keep looking for the problem to solve.

The thing about 3D printers, I quickly came to realise, is that they need input to provide output. All the skill in the world with the printer and its variety of materials wasn't much use if you didn't have a 3D file to start with. And I swiftly discovered that creating the 3D file to print was harder than the printing part.

What goes in must come out

At the same time, it occurred to me that the input part of the equation was arguably the most interesting. Attending the first 3D printing shows in London, I was reminded, yet again, of the early days of the internet by the refreshing variety of exhibitors. These ranged from huge companies (Adobe, showing how to manipulate 3D files in Photoshop) down to individuals who were producing their own brand of 3D printer using the RepRap model.

We were in the “let a thousand flowers bloom” era of the industry, and while I knew that most of the startups would fail, it was fascinating to read the embryonic trade press every day and find out how fast things were moving.

Another element then became important: Kickstarter. Several 3D printers launched on Kickstarter and raised incredible amounts of money, demonstrating a widespread desire to own one. Alongside this networked development, I started to encounter companies that were producing networked printer tools and management systems. I was looking at the birth of a 3D-printing ecosystem, and in my quest for opportunities, I decided to shift my attention to this space.

One of the first 3D printer companies to get out of the starting blocks was MakerBot. It also started the first online 3D file repository, Thingiverse (makerbot.com/thingiverse), where anyone could upload 3D files for distribution. Although MakerBot grew fast – in 2013 it was bought by one of the

RIGHT Modern scanners fall into two categories: light-based and photography-based





big two 3D printer companies, Stratasys – Thingiverse grew even faster. There was an open-source attitude and people were encouraged to upload their creations for free. The growth of Thingiverse didn't go unnoticed, and other file repositories started springing up, including Ultimaker's version, YouImagine (youimage.com) and CGTrader (cgtrader.com). These allowed designers to sell their files, adding that crucial commercial layer to the ecosystem.

As 3D printers started to spread, two young entrepreneurs decided to build a network that allowed people with printers to share them with those without access to a local machine. 3D Hubs (3dhubs.com) is the result of their work and now offers access to a global network of more than 20,000 3D printers, available for anyone who wants to print a 3D file.

Body scanning for fun and profit

Around the same time, an enterprising individual working on Coney Island, New York, designed and built his own body scanner using a Microsoft Kinect (pcpro.link/256scanner). He used Kickstarter to raise funds to scan and print every visitor to his studio. He also added the plans for his homemade body scanner to Thingiverse. The following year, I found a local company, 3Dify (3dify.co.uk), had built its own Kinect-based

body scanner and were scanning locals and printing them out on a bunch of Ultimaker printers.

I decided to look more closely at body scanning and discovered an embryonic industry with huge potential. I was inspired by the realisation that body scanning was at the same stage as early photography: it was slow, painful and expensive, and the results weren't up to much, but the potential as the technology developed was stunning. I imagined how the Victorians who went to have their photos taken would regard the cameras in our phones, and understood that an entirely new industry might be on the rise.

The scanning industry, like the 3D-print industry, has a history that has been bound up almost entirely with high-end industrial uses and prices to match. A combination of patent expiry, low-end demand and innovative approaches is leading to an explosion of new scanners.

These fall into two categories: light-based (LIDAR) and photograph-based (photogrammetry). Each approach has its adherents and, as with so many things, it's horses for courses. Certainly, it's too early to declare a winner. Both types are being developed cheaply as a combination of hardware and software. So how can you get involved?

At the low end of photogrammetry you can use a free app called 123D Catch, which stitches together photos on your phone into passable 3D files. In light-based scanning, a company called Structure (structure.io) came up with a scanner that clips onto an iPad and again raised millions of dollars on Kickstarter to turn it into a real-world product.

ABOVE The 3DPI rig is built using Raspberry Pi computers

"A complex ecosystem of scanning has developed and continues to grow as more options reach the market"

For body scanning, speed of process is key: any movement during photography can ruin the image. A developer in Amsterdam wanted to scan his young son regularly as he grew up and came up with the idea of using Raspberry Pi computer boards, with video cameras attached, to build a large rig for body scanning. The 3DPI scanner was born (www.pi3dscan.com). Professional versions of these rigs using DSLR cameras can cost hundreds of thousands of pounds, but he managed to build a 100-camera setup for less than €10,000. He developed his own management software for it and freely distributed the construction files, kickstarting another industry in the process. Now these rigs are available commercially from various producers.

A complex ecosystem of scanning has developed and continues to grow as more hardware and software options start to reach the market and are then integrated with the existing 3D-printing products. The 3D-scanning world encompasses dozens, if not hundreds, of sectors: health and fitness, medical, virtual reality, military, design, body printing and virtual clothing. While these industries are still embryonic, they hold huge potential and will eventually find their way into our everyday lives over the coming years.

As for me and my business opportunity? Well, my company, Shapie Me (shapie.me), hasn't yet launched, so I don't even have a product to shout about. What I can tell you is that we'll be developing a platform for the management of personal body scans. No matter what uses these scans will be put to in the future, my hope is that Shapie Me will facilitate integration.

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Useful links

- **Scan-A-Rama**
pcpro.link/256rama
- **The Scan-O-Tron 3000**
pcpro.link/256scanner
- **Structure scanner**
structure.io
- **3DPI Scanner**
pi3dscan.com
- **CGTrader**
cgtrader.com
- **Ultimaker's YouImagine**
youimage.com

DAVEY WINDER

“I can’t imagine how TalkTalk could have handled the post-breach interviews any worse”

Here are 15 expert tips to help you protect your data and avoid the schoolboy errors made by TalkTalk

As I write, I’m still shell-shocked by the TalkTalk data breach – and I’m in good company, as TalkTalk CEO Baroness Harding also appears to be suffering from PBSO (post-breach stress disorder). For me, the shock was tempered by having spent two decades in the IT security industry. When TalkTalk falls victim to a simple SQL injection attack, it might shock, but sadly it doesn’t surprise.

I’m not sure whether to blame Baroness Harding or the people who sent her to face the media without being properly briefed on how to answer their questions. Admitting that you don’t know whether all, some or any of the data was encrypted doesn’t look good. Maybe she really doesn’t know, in which case, a) what is she doing on TV answering questions? and b) why is she CEO?

Or perhaps she did know and thought avoidance was better than a straight “no”. Neither would surprise me, given that TalkTalk has fallen victim to a couple of breaches over the past year and appears to have learned not much, and implemented less.

Then things went from bad to worse, while appearing to get better. Baroness Harding went on TV again to state that “the amount of financial information that may have been accessed” was “materially lower than initially believed and would on its own not enable a criminal to take money from your account”. It’s good that fewer people were harmed by this breach – around 400,000, not the four million first suggested. It’s not good, however, that the initial post-breach plan didn’t instruct company officers not to spread FUD (fear, uncertainty and doubt) and to deal only in known facts. Better to say “we’ve been breached and don’t



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know how many customers are affected yet” than shout, *Dad’s Army*-style, “we’re doooooomed....”

More evidence of a lack of post-breach planning was the statement made by Baroness Harding to *The Sunday Times*, that TalkTalk has “complied with all of our legal obligations in terms of storing of financial information”, but wasn’t under any legal obligation to encrypt sensitive customer data such as bank account details. That convinced every customer I’ve spoken to that TalkTalk doesn’t care about spending money



“The TalkTalk breach is an prime example of why an organisation needs security awareness from shop floor to boardroom”

to protect data so long as it’s only the bare minimum to meet legal criteria. However, TalkTalk now says that credit and debit card data was tokenised – so they do care about data protection, they just made a pigs’ ear of communicating that fact after the breach. I can’t imagine how TalkTalk could have handled this any worse, and I speak as a customer, albeit of the business side of the company.

15 expert tips

The TalkTalk breach is an prime example of why an organisation needs security awareness from shop floor to boardroom, which must be built in, not bolted on, and include a breach-response plan. When your business has just been hacked, you won’t be thinking straight, and having a formal plan of action to follow can prevent the sort of schoolboy errors TalkTalk made. That’s why I was happy to take

part – wearing both journalist and consultant hats – in Security Serious Week (securityserious.com), which happened during the last week of October (designated as Cyber Security Awareness Month). This was such a good thing that one can argue it ought to be monthly, even weekly.

Security Serious Week engaged leading cybersecurity organisations to share their experience, expertise and resources with businesses and consumers who could make good use of them. There were free webinars, courses and lectures from some of the biggest names in UK cybersecurity, and as co-founder and managing analyst at IT Security Thing (itsecuritything.com): click on the “A-Z Tips” link at the top of the page. It felt like such a good idea that I’ve extended the theme to this *PC Pro* column, and here are my 15 expert tips to help protect your data.

1 Lie like a boss

So-called “security questions” asked of us by sites and services to verify our identity have never been secure and have never really verified anything. Anyone can get lucky by guessing, or search Google or Facebook to uncover your likely place of birth, name of your first pet or mother’s maiden name. If you have to play the security questions game then cheat, by which I mean lie, lie and lie again. Invent a different place of birth, an unlikely name for your hamster and an outrageous moniker for your mum. If they sound difficult to remember, store them in an encrypted note alongside your login details in a password vault service.

2 Close the path of least resistance

Cybercriminals are lazy and will follow the path of least resistance, and your default settings are open gateways to this path. Do. Not. Do. Defaults. It’s that simple, and it applies to everything from your router hardware admin login to your social media account settings.

3 Play the bad guys at their own game

Security training doesn’t have to be boring. The best security awareness comes from applying the three I’s: interaction, immersion and interest. Use games such as *Root the Box* (root-the-box.com), a capture-the-flag (CTF) game that will teach your tech staff the skills required to crack hashes, to get root and to think like

Website attack affecting our customers

If you're a TalkTalk customer, sign up for your year of credit monitoring by following the instructions on this page.

A criminal investigation was launched by the Metropolitan Police Cyber Crime Unit following a significant and sustained cyber attack on our website. We are continuing to work with leading cyber crime specialists and the Metropolitan Police to establish exactly what happened and the extent of any information accessed.



28th October 2015 – Latest Update

So that we keep customers informed about the cyber attack on our website on Wednesday 21st October 2015, here's our latest update.

Investigations so far show that the information that may have been accessed is not enough on its own to take money from your bank account. And sensitive financial information, such as credit and debit card numbers, was protected. The number of customers who

a hacker. Once you can think like a hacker, you can start thinking about how best to defend against them.

4 Take the insider risk seriously

If you accept that people are the weakest link in the security chain, you must also accept that some of those people will be your staff. What trips up many organisations is only considering in-house staff as part of the risk equation, when in fact all staff members are a potential risk. This is especially true when outsourcing data handling, so don't be afraid to ask a potential contractor what staff vetting procedures, awareness schemes and physical access controls they employ. Mitigating risk requires partners to be on the same page.

5 Security posture is not an internal-only exercise

It's important that your partners and contractors "get" data security the same way you do: the whole supply chain must figure in your overall security thinking, and unless their thinking is on a par with yours, you're asking for trouble. Sure, you're not responsible for the security policies of other firms, but you are responsible for performing due diligence to ensure they take security seriously enough to do business with. Make sure partners meet your high security standards.

6 Retire the old and infirm

Programs that are no longer supported or in use should be retired. Uninstalling programs you don't need and that don't receive security updates reduces the threat footprint available to hackers. If it ain't there, it can't be exploited.

7 Adopt the principle of least privilege

POLP isn't a nineties Britpop band, but rather refers to the "principle of least privilege", though it does in fact

adopt a "common people" approach to security, namely "never log in with administrator rights unless you're doing administrator things". Taking this approach yields the most security against attacks that seek to exploit the privileges available to them.

8 Shred the paper trail

While we naturally concentrate on our digital data footprint, there's a danger we might overlook the old-fashioned paper trail. Although "dumpster diving" is no longer so popular with hackers, your bank statements and other documents provide rich pickings for those who can be bothered to check your bin bags. Shredding any documents that contain personal information is a simple way to stop all but the most determined (and a cross-cut shredder will stymie even them) from getting useful attack ammunition.

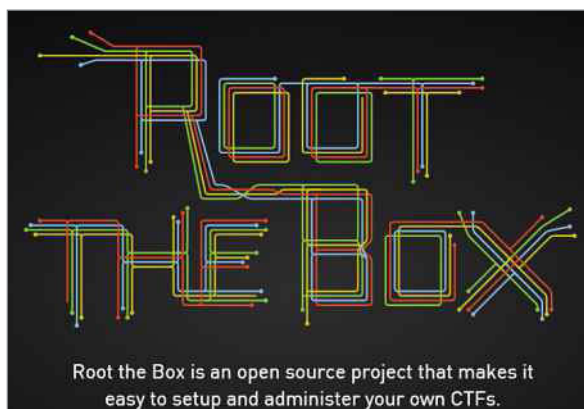
9 Scan your network for free

Use the resources available to you, and that doesn't have to exclude those on tight budgets: free tools such as AlienVault's ThreatFinder, driven by the Open Threat Exchange (OTX), scan for compromised systems by comparing log data against a live threat database, while Tripwire's

ABOVE TalkTalk's statements have been both fascinating and scary to watch

"We all have a past, and these days most of it's online in the form of a digital click-trail"

BELOW Games such as *Root the Box* put the fun back into security training



Root the Box is an open source project that makes it easy to setup and administer your own CTFs.

SecureScan will look for hidden internet-facing devices for 100 IP addresses on your internal network.

10 Use HTTPS everywhere

There's a good reason why commerce sites use HTTPS to encrypt their sessions with a digital certificate. It's because it provides additional protection for your data as it travels between client and server. Not every site will cough up the small additional cost for securing things this way, but you can still use HTTPS everywhere (well, almost everywhere) by using the browser extension of the same name. HTTPS Everywhere is a collaboration between the Tor Project and the Electronic Frontier Foundation that rewrites requests to HTTP-only sites to use HTTPS instead. It's free and it works. Use it.

11 Spring-clean your dormant online accounts

We all have a past, and these days most of it's online in the form of a digital click-trail. Those who would do us harm are always looking for an "in", and that can be made easier by leaving the doors to old accounts wide open. If you've left credit card details on a long-dormant site that's no longer getting security patches, your data is at risk. If you've left personal information and files on services you no longer use, these could also be at risk as you're less likely to check your security status there. Delete all sensitive data from services that are surplus to requirements, then delete the accounts completely. Wiping your digital footprints entirely is all but impossible, but that's no excuse for leaving a trail to your credentials.

12 Classify it

Only by knowing the value of all your data – which requires performing an audit of some kind – will you know which demands the costliest protection and which can settle for less financial investment. The most sensitive data probably shouldn't be stored in the cloud, but locally where you have more control over it. Valuable data must be encrypted, which costs, whereas there's little point encrypting low-value data that's already in the public domain. You won't know what security investment you require until you know your data inside out.

13 Take control of your keys

Letting your cloud provider encrypt your data for you sounds good, until you hear that the powers

Continued from previous page

that be have asked them to unlock it so they can take a look (but you won't hear, because in some cases they're legally restrained from informing you). Keeping control of your encryption keys means no-one can unlock your data unless you hand them over, so at the very least you're still in the "who gets access" loop. Solutions vary from encrypting data before it leaves your own network, from the use of on-premise hardware security modules (HSM) that generate and transfer an encryption master key to a virtual HSM within the cloud.

14 Secure. Audit. Repeat.

Once you've employed your security solutions through policy, process and practice, you must ensure that it's not merely in place, but actually working as it should. So undertake a security audit, including "fire tests" to check just that. Then repeat every six months to keep on top of things, and incorporate audit recommendations into future policy.

15 Policy matters

A formal security policy document is essential to underpin your security strategy as, without it, anything you implement will be built on weak foundations and prone to falling over if pushed hard. Take your time and get this policy right: the best plans cover not only data protection, but incident response. Consider this document as a dynamic device that can help understand what security means to your business, and devise a structured, real-world, response using strategic forethought. This policy, no matter how brilliant, is worth diddly squat if no-one reads it, or if everyone reads it but no-one understands it. Indeed, if even one person doesn't understand it, and that leads to a breach, you've failed. This is why education is so vital. That means educating everyone in your business, from the boardroom to the shop floor. What really matters is explaining security in a way that's relevant to the role of each individual and the threats they might typically encounter on a daily basis, and then maintaining those efforts to keep firmly on top of an ever-changing threat-scape.

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STEVE CASSIDY

"Similar strands of copper make my smartwatch buzz on my wrist and throw a Porsche down the Autobahn"

If thinking about IPv4 addresses makes you dizzy, how about the miles of copper wire powering everything from your smartwatch to your car?

In networking, we deal a lot in improbable numbers. People are often stunned that I can remember IP addresses after three or four repetitions, because they're aware of the pub quiz fact that IPv4 has room for four billion public addresses. To me, these addresses are intriguing, peppered with the history of the organisations that had the foresight to grab them. One understands how Bolt, Beranek and Newman are in that list, since they were at the time a large American technology consultancy, but the UK Department for Work and Pensions? Really? Start perusing the ownership, of the list, with great swathes taken up by assorted organisations, and that four billion starts to look as crowded as it is.

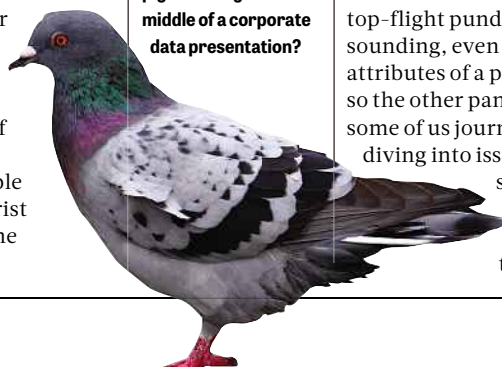
I wasn't expecting my trip to Las Vegas, for Software AG's Innovation World, to give me any especially sharp jolt out of my comfort zone when it comes to numbers, and what that actually means for networks and computing. For all those of you who find that IPv4 gives you vertigo, that it's far from being some cosy labyrinth you can solve using fingers-and-thumb maths, here's the idea that gave me that same sense of dread about infinities. Copper wire. Not even buried copper wire, the stuff over which far too many of us still receive our internet service. This was the ultra-fine, ultra-pure stuff that's still used to wind around the armatures of electric motors. If there's any other field that's developed as fast as IT over the past decade, it's electric motors. Whether they're 4mm across (pcpro.link/256motor1) for model helicopters, or 130 horsepower (pcpro.link/256motor2) for electric cars, they all use copper wire. I got vertigo while thinking about how similar superfine strands of copper, by passing electric current, can make my Pebble smartwatch buzz on my wrist or throw a Porsche down the Autobahn at 220mph.



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"Wire squirts out of the dies and gets wound onto the spools faster than a man can run, all day, every day"

BELOW What was a pigeon doing in the middle of a corporate data presentation?



In order to do either, the wire must be well made, to a level of consistency that frankly beggars belief. Think about how to instrument a factory full of wire-making machines, machines that never stop deliberately. Wire squirts out of the dies and gets wound onto the spools faster than a man can run, all day, every day. Software AG brought the CTO of the wire-makers to their Vegas seminar, and after each flight of fancy from other panel members about "machine learning" or "Big Data" or "customer tracking", he would just say "we make wire". This is the German sense of humour at its best: what that seminar needed was someone to provide an intellectual on-ramp, a way of going from something you can see and feel, right the way up to the leading-edge work being done in data analytics in late 2015.

Once I'd stopped my brain boggling at the relentlessness of that wire-making factory, I began to understand why they'd plonked such a plain and simple example among so many people trying to sound clever about middleware – because that's what Software AG does. The firm has a variety of database and codebase products that glue together various streams of business data into a coherent workflow. And if that sounds wishy-washy, then that's what I intended – describing their stuff has to stay a bit wishy-washy until a specific client bends it into a shape that they can use. Such loose upfront descriptions are actually symptoms of a healthy consultancy and customisation revenue stream.

You can always guarantee that top-flight pundits will go for the sexy-sounding, even slightly intimidating, attributes of a product portfolio, and so the other panel members (and some of us journalists) wasted no time diving into issues such as how a data space of thousands of stock lines and sub-types drives the demand for

artificial intelligence to design the campaigns of discount coupons being printed in American newspapers.

I was only too pleased that, at the end of each of those explorations of how analytics makes for disturbingly well-targeted junk mail, that German industrialist at the end of the table would doggedly say “we make wire”. He has, for example, a system that detects changes in the visual representation of the stream of wire – some cameras and software developed by the Fraunhofer Institute (pcpro.link/256fraunhofer), which thankfully do not store a 24-bit JPEG of each 10cm stretch of wire every ten milliseconds. That’s just the sharp end of over 20 different sensor types that sit on his network, reporting on everything that can go wrong with the materials and machinery that spew forth all that wire.

Note that isn’t 20 sensors, which would be hard enough, but 20 types of sensor. All just watching those millions of metres of wire – how hot it is, how hard it is, how strong against tension, how conductive and how thick. For each 100m length of wire, a summary of those attributes is stored to disk against the event of a warranty or performance claim at some point in the future. Maybe it’s just my memories of being the guy with the pager, on call throughout the night, that gave me a special frisson of fear when faced with this 24/7 cascade of information. That, plus the idea that the data generated by those sensors has to be kept, but not really analysed very much – any emergent properties of those wires might not become apparent or be subjected to analysis for many months or years after they leave the factory. If, like me, you find this disturbing and you’d prefer a more familiar, concrete example from our kind of business, then let me discomfort you a little with a secret from Lexmark.

Yes, the Kentucky-based printer manufacturer has need for some heavy-duty database middleware. Not, thankfully, to track their printer parts manufacture and assembly operations (although I’m sure that comprises the same kind of dizzying data abyss as the wire-making factory). Instead, it was there to talk about customer-side printer management. Lexmark makes at least as much money from managing printers installed in businesses as it does from making those printers in the first place and, at first sight, this is reassuringly familiar.

It watches toner consumption, for example, so the replacement cartridge arrives just as its predecessor is about to run out. It implements variable-price contracts, a print-more-stuff, get-a-bigger-bill arrangement. It can figure out whether a business would do better with a different mix of big and small printers, and some of Lexmark’s printers are, of course, pretty big. It installs environmental monitors, room-temperature sensors, humidity sensors and all that jazz. This presentation on the vastness of the “Lexmark Printer Universe” was an excuse to show some of the most intricate, over-developed diagrams I’ve ever seen. Up in the corner of the last diagram was an innocuous, dashed-line box labelled simply “Pigeon”.

I couldn’t let that go: all that major corporate-type data presentation and then we arrive at “Pigeon”. I had to ask, and it turned out that Pigeon is Lexmark’s internal codename for its Internet of Things (IoT) traffic gateway product. It seems that a mental image of a system that flaps about and emits unpredictable squawks best summarises Lexmark’s IoT experience to date. This is not reassuring after those millions of miles of copper wire. In fact, it’s another data point on the graph, further support for the Software AG team’s assertion that the place where dry technical facts, careful budgeting and proposal-writing meet the thousand-yard stare, the sleepless night and the plaintive, emotional board meeting is in that previously calm and unruffled world of middleware.

Longer than a vet

A tip for you data-centre hosting types: if you take a load of journalists around one of your facilities, don’t make a big thing out of your “borehole”. That tempts too many puns from people contemplating a data centre, which is by definition a place where nothing is supposed to happen (especially while you’re wandering around inside it). On this occasion it was Equinix, and if you’re curious, its borehole goes down more than 300 metres into the



ABOVE Software AG’s Eric Deffaut takes to the stage at Innovation World, surrounded by technology

“An image of a system that flaps about and emits unpredictable squawks best summarises Lexmark’s IoT experience to date”

aquifer. If the building experiences outside air temperatures above 20°C, water spouts up from the borehole to be sprinkled over the chiller pipes, up in the roof heat exchangers.

There were a lot of other data-centre facts and figures to toy with during this tour, but, as always, I forgot them and instead listened to the little asides and snippets that the people came out with as we walked around. In this case, I wasn’t encouraged to take pictures, and the promised “official” shots didn’t make it to us before press deadline, so you’ll have to trust me when I say that 6,000 square metres of data centre looks exactly the same whichever floor you step out of the lift onto. Of course, for a facility that boasts “five-nines” (that means 99.99999%) reliability, you’d expect that not much would be going on, or at least that what was happening wasn’t very physically apparent. Equinix is keen to point out that all of its buildings, new and old, get the same reliability score, even though the older ones are somewhat less energy-efficient than the one with the, um, borehole in the middle of it.

What I was supposed to be there for was the Equinix Apprenticeship Programme, which takes a couple of promising people per year and puts them through a four-year day-release study and work programme, with an NVQ to show at the end of it. Given that this whole programme was put together at Equinix’s behest by local colleges, both in terms of the study programmes and the candidate selection process, it became clear that the training to become a data-centre specialist is four years, plus some previous time studying in college

on an allied topic. In other words, between five and six years overall, or longer than training to be a vet.

Equinix's UK MD, Russell Poole, was keen to explain that this project had been driven by Equinix, rather than the colleges coming to them, and that it was showing signs of long-term legs for both the apprentices and the business. I counted at least 12 young chaps larking about in that quiet, engineer-like way in the pauses between Russell's speech, the data-centre tour, the cyclical visits to the boardroom for cross examination by journalists, and the highly unexpected, but obviously very important bit at the end – they cracked open the door of a meeting room with lots of champagne in it, and announced that the apprentices' parents were arriving and would we mind awfully if they kicked us out?

Russell explained the hard-nosed business angle. In common with many of the rest of the rack-hosting business sector, Equinix is merciless in chasing down the last microwatt of efficiency and fraction of a penny on overheads costs. However, it is also exquisitely aware that the skills required to get to those profit sources are a very rare resource in themselves. Looking after good technical people is an even rarer skill.

The merciless efficiency mindset tends to lead towards a job market that promotes the narrow and peculiar advantages of a floating, temporary, on-demand workforce. Equinix's discovery, it seems to me, is that by giving in to its distinctly human impulse toward mentoring and educating, it had almost by accident rediscovered the old industrial tradition of apprenticeship – which, as another Equinixer pointed out, was doubly strange since American companies don't think of apprenticeship as a high-status activity, either for the business or for the apprentice.

On the way back from my visit to sunny Slough, I had plenty of time while crawling along the M4 to notice a hoarding advertising Heathrow and its environs as a great place for businesses to set up an apprentice scheme. Pure coincidence, or advert positioning, as my cellphone crawled past, plugged into my car in emergency-satnav duty?



Big changes in backup

In the latter part of 2015's fast-moving convention and trade-show season, I'm sorry to say that I managed to stand up a couple of people who are owed an in-print apology. On the occasion I'm most ashamed of, I chatted with the guys from Arcserve when I was strictly supposed to be sitting with Ray O'Farrell, the CTO at VMware. Not regional CTO, not even CTO of one product range, but the CTO. Eventually we sat down and had a reverse interview in which he mostly wanted to know what I thought were the hotspots within the IoT sector – an odd question from a guy in virtualisation, you might think, but these days that includes networking. IoT looks like an *enfant terrible* when it comes to types, quantities and eccentricities of traffic.

My other excuse is that talking to Arcserve was mandated by its recent amicable split from the Computer Associates (CA) mothership. That's a nostalgia trip for old IT types who cut their teeth (and sometimes ended up grinding them) on Arcserve for Novell. It's also a bit of a criticism of CA as stewards of the brand – but the new team is pretty upbeat. What I mean by "new team" here is, of course, an oddity, because it's the same people who once lived inside the business unit, but with nice new badges on and a bit of money spent on a new logo and some cute products to show off.

Again, that wouldn't be too interesting were it not for the fact that, within a few short weeks, Veritas emerged from the shadowy cloak of Symantec. That's two backup businesses, both of which were takeover targets over a decade

ago, suddenly getting the muscle together to stand on their own feet again. Both are doing it on the back of a sharply increased interest in backing things up and restoring them, and both came out with the same nightmare scenario. What if you had to be able to show the lifecycle of a document that had become pivotal in a legal case, and said document was sloppily shared in an online file repository?

Their solutions are related to backup: both will now do a backup appliance that looks suspiciously like an old-school internal file

server. These appliances come with a wide range of membership modules for the popular public cloud storage services, and can be configured to periodically snapshot the state of your files onto those services, against the chance that the service just loses them (which does happen, as Google users in Europe discovered this year) or, if you prefer, the far more likely situation arises of someone thoughtlessly deleting something they may later wish to rely upon in court.

In the early days of cloud, it was the remote data centre that was thought of as the safe harbour and your local, creaking, ancient and overfilled file server that was the risky one. Now that picture is being inverted, and not because data centres have become more flaky. The main source of unreliability is the sheer spread of different software providers and their enormous variety of ambitions, software development cycles, security procedures, hosting contracts, SLAs and diligence.

The churning marketplace in hot collaboration tools makes the plain old email server of yesteryear look like a cosy, protected backwater. And the people who are bearing the brunt of the bad news when there's a merger or a takedown, or a tornado takes the roof off the hosting company, aren't the vendors of these services, but rather the poor guy who made some sketchy promises about being able to back up and restore all your stuff. Little wonder both Arcserve and Veritas feel they'd like to have a crack at this extended market without encumbrance, micromanagement or interference.

 cassidy@well.com

ABOVE Training to be a data-centre specialist takes five to six years – longer than to be a vet

"In the early days of cloud, it was the remote data centre that was thought of as the safe harbour"

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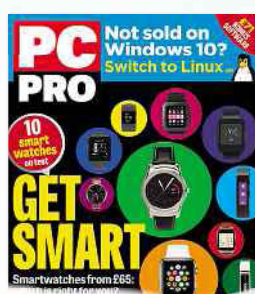
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Futures



We explore the trends and technologies that are set to shape the future

Hacking the Internet of Things

Looking for the flaws in new mobile applications **p126**

The future of desks

Altwork's smart workstation takes a more flexible approach **p127**

Geek Day Out

Take a walk through Scottish science history **p128**

Building blocks: why tech is going modular

Modular designs could let us personalise wearables and extend the lifespans of our smartphones, but challenges lie ahead. **Nicole Kobie** reports

Your smartwatch vibrates; it's running out of battery. Rather than dashing to the wall for a power socket, imagine simply popping out a link in your wrist strap and slipping in a new battery.

This is the promise of modular devices: drop in a new camera, a refreshed battery or extra sensors to upgrade or personalise your smartphone, smartwatch or even desktop PC.

We're a far cry from this scenario today. Most manufacturers glue in smartphone batteries, and SD slots are rare enough to be notable in reviews, so the few modifications we could make are usually off the table.

This might be set to change. Google is working on Project Ara, a modular phone that allows you to slot new components into the "endoskeleton" of the base device. The Fairphone 2 uses a similar design ethos, allowing users to replace the battery and other components.

It's not only smartphones. A modular smartwatch, Blocks, has raised \$1.4 million on Kickstarter, while Acer unveiled the Revo Build, a PC with Lego-like stackable components designed to make upgrading simple, at IFA in September.

What has spurred this swing to modular hardware? And does it have any prospect of long-term success?

■ Building Blocks

Serge Didenko and his co-founder Alireza Tahmasebzadeh have been working on the Blocks smartwatch for three years. The inspiration for the modular design was a disagreement over which features to include in their device. "Neither of us could agree on which features were more important," Didenko told *PC Pro*. "I wanted all the health and fitness features and my co-founder wanted gesture control and more business features. We each wanted our own personal experiences from a wearable."

This was also true of the potential customers they polled. "They're not all the same," said Didenko. Athletes may desire a heart-rate monitor, but that may not leave room – physically, financially or in terms of battery life – for other features, such as gaming gesture controls, GPS, a fingerprint

ABOVE The Fairphone 2 was the first modular smartphone to hit the market, beating Google's Project Ara

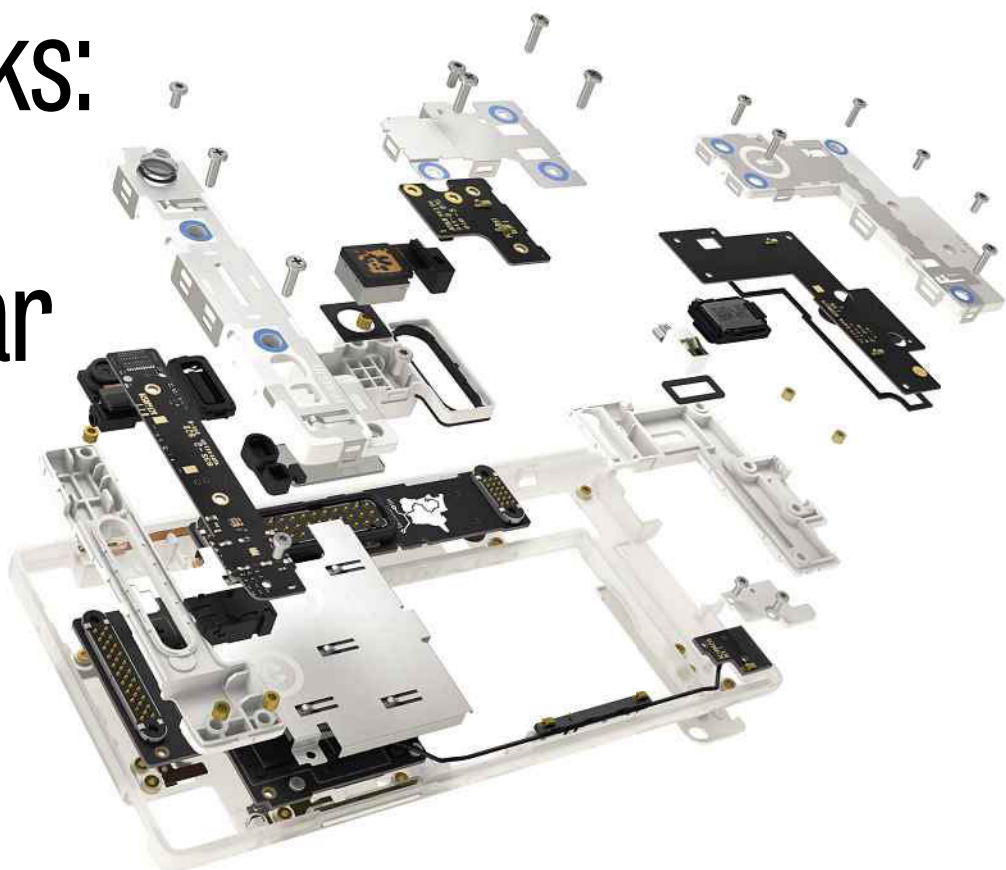
scanner, NFC payments or dual-SIM support. "The number of sensors available is really large, but bringing it into a single device would be very hard," he said. "Big tech companies today are having to compromise on the features they include in a smartwatch, because there's only so many you can fit into a single watch."

The Blocks device is a complete smartwatch, featuring an activity tracker, 1.5 days of battery life, voice controls and haptic feedback, and users can add extra sensors to the strap for \$30 each. "Why should we compromise and not include it when some people will love it?" said Didenko.

Acer believes modular designs could bring mobility to desktop PCs,

"If your Blocks smartwatch is missing a feature you can't live without, there's no need to shop for a new watch – you can add another module"

letting you carry around your hard drive to play music, your power bank to charge other devices or your projector for presentations, according to Acer spokesperson



Manuel Linnig. This offers “scalability to your needs or situation,” he said.

■ Against the grain?

Analysts are sceptical about whether most people crave a mix-and-match approach. “Modular devices are moving in the opposite direction from more than ten years of mobile innovation,” said IHS analyst Ian Fogg. “Device makers have minimised the size of their devices and improved reliability by removing all moving parts such as removable batteries, hinges on flip phones, slide-out keyboards, often dropping memory card slots, too.”

Take Apple, the most successful mobile and smartwatch maker. Its devices are “completely integrated” and feature no moving parts or replaceable components, Fogg noted, adding that this approach has worked across MP3 players, smartphones, tablets and even laptops. “Apple’s success with tight integration has driven all of its competitors to pursue a similar industrial design strategy, and drop the flexibility of modular designs,” he said.

Consumers have traded the ability to upgrade or personalise devices for slimmer, sleeker devices, he added. “The challenge for companies seeking to make a modular device... is how to match the competition in size and weight while maintaining the same quality components,” he explained. “Early signs from Project Ara indicate



Google has not solved this problem. The pre-beta designs are notably bigger than similar smartphones that are tightly integrated.”

While Fogg insists his first impressions of the Blocks smartwatch are good, he said it will be difficult to keep the modules robust and reliable without adding “significant bulk” on the wrist. “The likely outcome will be a bulkier strap design than competing smartwatches,” he said.

Aside from the difficulty of keeping devices slim enough to wear, modular designs raise other issues. Didenko said he and Tahmasebzadeh worked for two years with partners to build “strong and robust” connectors and develop a suitable communication protocol, while Acer’s Linnig said the main challenge was to “make sure that all the blocks work together with the magnetic connector” without interfering with the components.

ABOVE The Blocks smartwatch allows users to make contactless payments via an NFC module

Affordability is another problem. The base Blocks smartwatch is currently selling for \$295 (£195) on Kickstarter. This includes four modules, with extras at \$30 each. For comparison, the Pebble Steel costs only £135.

■ Long-term investment

Not all consumers will be willing to pay more for flexibility, but Didenko notes that modular wearables may well have a longer lifespan. If your Blocks is missing a feature you decide you can’t live without, there’s no need to shop for a new watch – you can simply add another module. “They’ll be made to last,” he said.

Right now, Didenko argued, rivals’ products aren’t. “The way tech companies and hardware manufacturers work today, they purposefully make devices that are not meant to last,” Didenko said. “They do this because they need to ship another device next year and make you pay an extra \$500 or something for your phone. The whole business model is built around building devices year on year that are not able to last, because otherwise they won’t get their revenue stream.

“We’re trying a great alternative. We’re building devices that will last, and because they’re modular we will get extra revenue from extra modules [when customers upgrade],” he said “We’re making it good for our customers and good for ourselves.” ●

Bits and pieces: modular hardware available to buy soon or now



Blocks

The Blocks core is no different to any other smartwatch, but you can add modules via the strap to extend its powers. The modules are hot-swappable, so you can pop in a heart-rate sensor before heading for a run, but leave it off the rest of the time to save battery. Blocks runs Android, but also works with iOS. It currently costs \$285 (£189) for the base watch plus four modules, with extras priced at \$30 (£20). It’s expected to ship next spring.

pcpro.link/256blocks



Acer Revo Build

The Revo Build is a mini-PC that lets users customise, without cracking up the chassis, by stacking “blocks” with different features to the base unit. At launch, the only extra module available is a 1TB hot-swappable hard drive – easily added to any PC via a USB cable – but there are plans for a wireless power bank, an audio block, a projector, better graphics and more. The Revo Build will cost £199 and come with an Intel Skylake Pentium or Celeron, as well as 8GB of RAM and 32GB of flash storage.

pcpro.link/256revobuild



Fairphone 2

Having pipped Project Ara to release, the Fairphone 2 is the first modular smartphone you can actually buy. Unlike most modern phones, you can open it up, replace the battery and unscrew and upgrade components such as the camera and speaker – because they’re not glued in, the phone is easier to repair. The back cover can also be replaced, and versions with NFC and wireless charging are being considered. The Dutch design will cost €525 (£373) and start shipping in December.

fairphone.com



Q&A Learning to hack the Internet of Things

Ken Munro sees a connected device and all he wants to do is hack it. Here's what the Pen Test Partners security researcher has uncovered about smart home tech – and why you may not want to turn on a Wi-Fi-connected kettle

THE RUSH TO CREATE the Internet of Things (IoT) means manufacturers are cramming connectivity into everything – without making it properly secure. That makes Ken Munro's work easy: he's a researcher with Pen Test Partners and spends his days poking holes in so-called smart devices.

Do we really need our kettles to connect over Wi-Fi? If we do, how can we make them more secure? That's what Munro is trying to answer – and while he's not sure a kettle or coffee maker needs net access, there's one upside to his work: he gets a cuppa at the end.

■ Why did you want to hack the iKettle?

Because it had the word “internet” in front of it. Why on earth would you internet-enable a kettle? I mean, it's just a ludicrous concept – it's a Wi-Fi kettle as well. It doesn't work on mobile data, so it's not as if you can tell the kettle to boil as you're leaving the office with the intention of it being warm in 15 minutes' time when you get home. You can only tell it to boil when you're on the same Wi-Fi network, so you're in the house.

■ What did you find when you hacked it?

For us, it was as bad as it gets. In order to set the kettle up on your Wi-Fi network, you need to give it the network key. And we discovered that, by sitting outside someone's house, you could send a deauthentication message to the kettle, create a fake access point and the kettle will then join you. So that was a “fail” in itself.

A user had configured the device with an Android mobile application. It failed to change the passwords



BELOW There is the potential to bypass the thermal overrides and, therefore, cause the kettle to overheat

to the interface after you set up the kettle. It was still the manufacturer's default, which is six zeros, which you can find in the manual for the Wi-Fi module.

The consequence of that is, once you've got that password, the kettle would then disclose the user's Wi-Fi key. Once you've got that, you have basically got everything you need to compromise the user's network. And now I have control over their DNS. And once I've got control over DNS, I've got control over all of their internet traffic.

■ Is that what you expect to find with the coffee machine you're hacking?

That's what we're hoping to find – or hoping not to find. But, again, all of these devices deal with heat. Is there a way to bypass the thermal overrides within these devices and make them overheat? Is that going to be possible? I don't know. This is speculation at this point.

One of the other devices we're working on at the moment is a Wi-Fi-enabled oven. So, obviously, the heat involved is a lot greater, and there's much more potential.



■ But you would need to be sitting outside their house?

It's mitigated to a point because it's local. I've got to be adjacent to the house. However, you can also use information collated on websites

such as **wigle.net** to geolocate victims. You can find out if someone's got a kettle from online databases and go out and find people to attack. And that's a bit creepy.

But what this comes down to is that pretty much every sort of consumer home IoT device comes with a mobile application. And by far the easiest way to compromise these devices is to look for the flaws in the mobile applications themselves.

■ Do you have any security advice for IoT manufacturers?

If security researchers try to get in touch, you should definitely talk to them. That's because researchers are usually well intentioned and you'll end up really annoying a researcher if you ignore them. It's, therefore, far better to have a bit of friendly, free advice from a researcher than ignore and annoy them. Moreover, they'll probably give you everything you need to fix it for free. ●



Is this the future of desks?

Altwork's smart workstation gets you into the perfect position to type

Lying down on the job isn't normally encouraged, but one startup has created the ultimate workstation to do just that – all while still comfortably typing away.

Research suggests sitting all day at work is unhealthy, and standing desks are now popping up in offices. But Californian startup Altwork is taking a more flexible approach. Its Altwork Station can shift into four different positions at the touch of a button: sitting normally, standing, collaborating with others by sharing your monitor, or – and this is the one that grabbed our attention – laying back with your laptop held in position above your head.

While that's likely to help ease complaints such as back pain or wrist strain, the company admits there's no "ergonomic

data we know of" that shows working in a reclined position is healthier than sitting. Instead, it argues that the real benefits come from changing position, rather than sitting the same way all day.

Good luck getting your boss to approve an Altwork Station for your office, though. The first version will cost \$5,900 (£3,825), although there's an early adopter discount that knocks \$2,000 from that price. It will start shipping internationally at the end of next year.



1 The Altwork shifts into four positions, including the reclining "focus" mode.

2 Users can easily move through the positions using buttons embedded in the desk.

3 When you lean back, your keyboard stays in place using magnets that adhere to a steel plate under the desk.

4 It comes with a steel mouse pad to magnetically hold your

mouse when not in use.

5 The Altwork Station supports multiple monitors up to 16kg in total weight, and a side mount for laptops, but the designers didn't include a cup holder for coffee.

Crowdfund this!

Our pick of UK tech projects on Kickstarter and Indiegogo

Openrout Raspberry Pi router

The Raspberry Pi can pretty much run anything, eh? The low-budget computing board is at the centre of many crowdfunding projects, including this open-source router designed to connect all your devices, including smart-home and Internet of Things (IoT) gadgets.



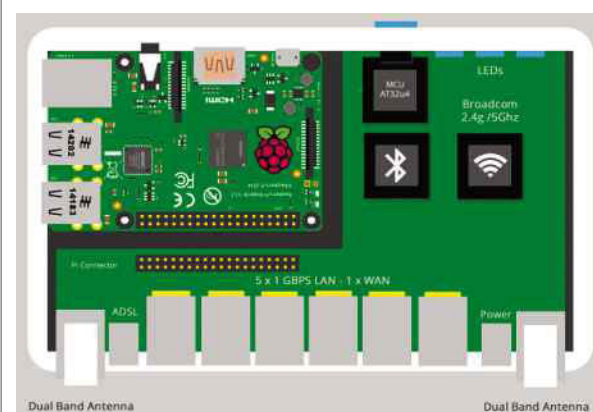
Do I really need a router that does Internet of Things rather than just, you know, the internet? Probably not yet, but routers are starting to load up on features ahead of the predicted IoT explosion – Google has even made its own, the OnHub. To make sure it can reach all those Bluetooth-enabled IoT devices in the home, multiple Openrout devices can be linked together to create a Bluetooth mesh network.

Does it offer anything to people who don't want a Wi-Fi dustbin? Most routers aren't very secure, as they've been designed for ease of use rather than keeping networks safe. The Openrout has a host of security features, including a physical button to access settings, so hackers can't get into the management console by entering the default gateway address and logins.

And for all this you need a Raspberry Pi? The computing board manages the router, but also acts as a mini private cloud, letting you store up to 25GB of files that can be accessed online. You can plug in an external hard drive for more storage space. When the Raspberry Pi is updated, you can easily upgrade the router.

Will this get backed? Its prospects weren't good at the time of publishing, with just one backer for the \$100,000 goal. It's a flexible funding model, meaning the developer will get all of the cash, even if that target isn't met. If you want an Openrout, it'll cost \$200 (£131), but you can also show your support by voting with \$1 for an alternative name, Blurout – which we prefer to Openrout, though not enough to enter our PayPal details.

Link: pcpro.link/256openrout

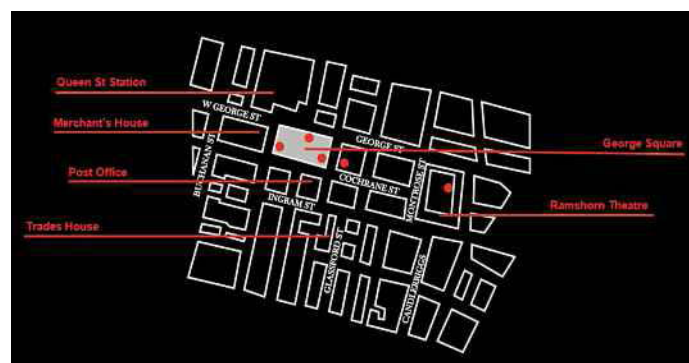
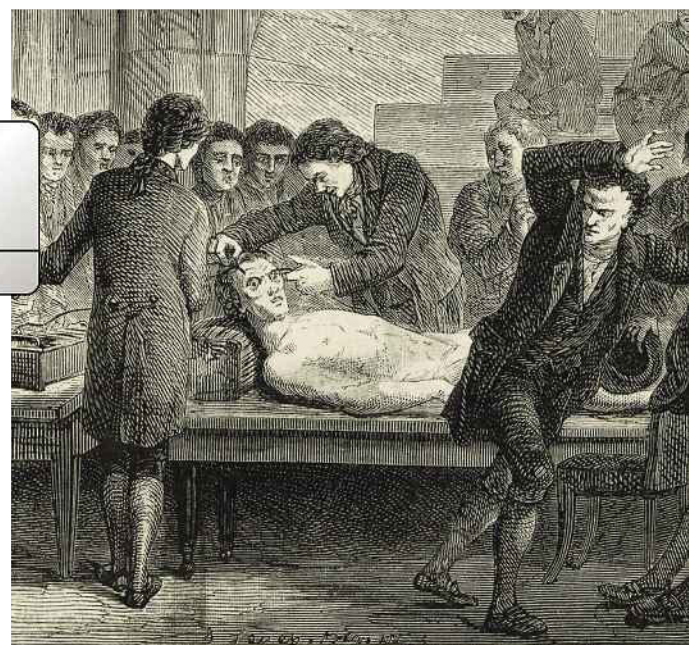




Geek Day Out: Science on the Streets

SCIENCE
ON
THE STREETS

Take to the streets of Glasgow for a walk through Scottish scientific history, from Lord Kelvin to James Watt



It's time to hit the road in the name of science. The history of technology, from the TV to the steam engine, lives in Glasgow's alleys and squares, and you can uncover the most intriguing stories with a free Science on the Streets walking tour by top academics.

Dr Jochen Bruckbauer, a researcher specialising in semiconductor nanostructures at the University of Strathclyde, helps run the strolls through the past. "The tour appeals to people who are curious about the technology that surrounds them and who like to understand how things work," he said – and if that isn't a perfect description of *PC Pro* readers, we don't know what is.

Glasgow's science and tech history is often ignored, the organisers argue, but the two 90-minute tours shine a spotlight on the

Scottish city's importance in creating many of the inventions we take for granted today. "The tour explores the history and the people involved, and visits some of the sites in Glasgow related to them," Bruckbauer said. "The tour ranges from Lord Kelvin, physicist and namesake for the absolute temperature scale; John Logie Baird, the inventor of the television; Thomas Graham, who developed dialysis; James Blyth, inventor of the first wind turbine; to James Watt, whose improvement of the steam engine kickstarted the industrial revolution."

However, Bruckbauer's favourite is more grisly: the story of murderer Matthew Clydesdale. "Not to give too much away, but the story includes a body snatcher, Frankenstein-like experiments, an affair and the invention of a piece of scientific apparatus that is crucial to the saving of lives today," he said.

Science on the Streets started as a walk

TOP RIGHT The tour takes in the gruesome 19th-century story of Matthew Clydesdale

ABOVE LEFT The city-centre tour explores local landmarks such as Glasgow Cathedral

taken by University of Strathclyde students to learn about measurement from the late Peter Maas and Dr Carol Trager-Cowan. "Through a walk on the streets of Glasgow the students were asked, for example, how to estimate the height of the Walter Scott monument and asked to consider what is necessary to allow bridges to expand and contract during hot and cold weather," Bruckbauer said.

That school trip evolved into tours, but Bruckbauer said Science on the Streets is not only for students.

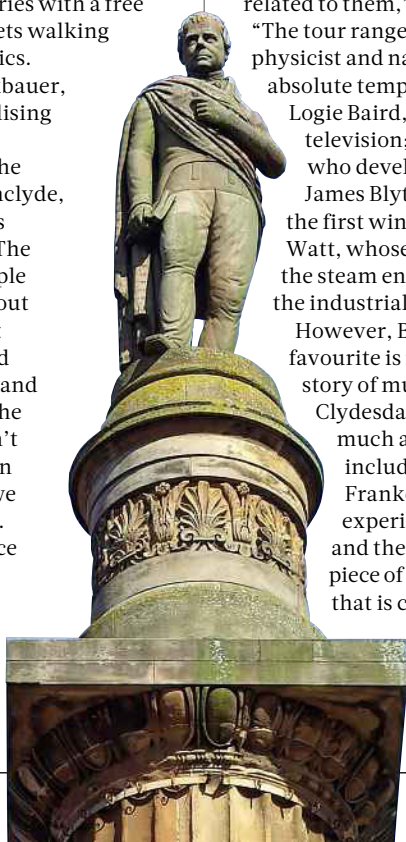
"We adapt the tour to the age of the participants, so it is suitable for all ages," he said. "We've had whole families, including babies to retirees."

“The tours shine a spotlight on the city's importance in creating many of the inventions we take for granted”

You'll want to bring an umbrella just in case it rains, but Bruckbauer assures us that the weather is kind to tour attendees "more often than not", although we're not sure if his weather forecasts are strictly scientific...

The free tours run during events such as the Glasgow Science Festival in June, or you can book your own via tours@scienceonthestreets.org.uk

LEFT The first walk involved working out the height of Walter Scott's monument



Is it legal to hack your smart car?

Accessing data from smart car software is now allowed in the US, but what about here in the UK?



Vehicle owners and researchers in the US have been given the right to extract and examine car software without breaching copyright for the first time. The ruling sides with digital rights activists from the Electronic Frontier Foundation, who say that it should be considered as fair use.

Manufacturers had argued that allowing such access could be unsafe. The ruling follows the Volkswagen scandal, in which software concealed higher-than-permitted emissions.

Brits have limited access to their car's code, according to Mark Owen, partner with Taylor Wessing, who specialises in IP law. "There are several laws that may limit the extent to which car owners can 'hack' the programming in their cars, namely rights under the copyright legislation concerning copying of code and evasion of technical protection measures, rights in confidential information, and the Computer Misuse Act," he told *PC Pro*. "The ones most likely to apply are confidential information and the anti-circumvention provisions."

It may seem incredible that it's illegal to hack the car you paid for, but Owen noted we don't normally own software, just the right to use it. "This will usually be subject to restrictions making it clear that the licence does not include the right to hack the software," he said.

Researchers have faced court action for breaking into

car code before. "University researchers wanted to present to a conference on the encryption applied to Volkswagen key fobs," Owen said. "The owner of the technology, Thales, and Volkswagen were granted an injunction stopping the researchers from discussing the encryption at the conference."

Over the summer, it was revealed that such key fobs are insecure – a fact that could have been made public three years ago, if not for the injunction.

■ Right to hack

The law could change with the EU's new Data Protection Regulation, set to be introduced later this year or early 2016, Owen noted. And, while it's not a new issue, the growth of the Internet of Things means more and more devices will run code.

"While there may be an argument that people feel they should be able to reverse-engineer whatever they 'own', and also that security flaws should be called out, there are strong arguments in favour of limiting this," Owen said. "The more access is made possible, the greater potential there will be for malicious acts, whether through breaches of security, threats to public safety or access to private information."

"Some legal limits need to be placed upon hacking, but the debates tend to be about how far those limits should go," he added.

Best of **alphr.com**

Our sister site Alphr covers the latest in tech and science – here are the top stories from this month on the innovations that are just over the horizon.

Dead scary: how games deal in terror

Why are games so good at scaring us, even when we know it's only pixels on a screen? Developers use a range of graphical tricks to horrify us while playing, but it's not the visuals that make the joypads jump out of our hands, according to Thomas Grip, creative director at Frictional Games. "Sounds sound a lot more real than how graphics look," he said. While an unseen monster's sinister breathing might spark terror, developers must still make the monster frighten us when it steps on screen, and for that they're turning to artificial intelligence. "If the AI does something stupid, it breaks the horror illusion and the enemy isn't scary any more," noted Falmouth University games researcher Michael Cook.

pcpro.link/256alphr1



Appliance of science to our justice system

Is our faith in the justice system misplaced? Psychologists suggest yes, saying people aren't sceptical enough about barristers and biases. To help, courts need to mimic scientific solutions. Professor Tim Valentine of Goldsmiths College said police should use "blind" video lineups for suspect identification by witnesses, in which even the police officer doesn't know who the criminal is, eliminating any chance of accidental encouragement. "This isn't a radical idea: clinical trials of drugs have been run blind for years," he said.

pcpro.link/256alphr2



Smart homes step outside

There's more to the Internet of Things than smart homes. At Intel's IoT conference in San Francisco, the chipmaker showed off other use cases, including sensors to help keep firefighters safe by measuring heart rate, carbon monoxide levels and temperature, and by tracking their location. Connected sensors can also help boost agriculture, improve security for shops and monitor children.

pcpro.link/256alphr3





It's not government snooping that has **Jon Honeyball** worried: it's whether our data will be safe

The headlines surrounding the recent draft Investigatory Powers Bill should come as absolutely no surprise to anyone who has an even slightly cynical view of politicians, the government process and the enormous amount of money being spent in this area by various government departments. As my late father taught me, "follow the money", because that is where the real underlying issues will lie.

It should be no surprise that the home secretary wants sweeping powers to track what we are doing, how we are doing it and where. This is the internet equivalent of all the number-plate recognition systems and Gatso speed cameras that have been planted around the road system.

And the ongoing cry from those who, strangely enough, have managed to isolate themselves from many of these requirements, is that "you have nothing to fear if you are doing nothing wrong". As my good friend and fellow contributing editor Davey Winder says, "you have nothing to fear if you have nothing to say".

I'm actually not particularly bothered about the provisions from a government or GCHQ point of view. Now, before you rip apart this magazine in a fit of pique, let me explain my position further. The reality is that, if a government department wants your data, they will come and take it. That's been the case in the past, and it will be so in the future. I don't like the idea, and don't approve of it at all, but as sure as a new iPhone in September, it's going to happen.

That might seem defeatist, but the relevant government departments will ensure they have this stuff, by hook or by crook. Of course, nothing will help when your world implodes because the wrong information is tagged to the wrong person, and you're hounded by everyone who is supposed to be on your side. But that is the underlying reality of the government and judicial process. We can but pray that the miscarriages are rare.

No, the problem is the mechanism required to hold this data. My ISP will have to do so for a year. My telco has to store all those call records. And I don't know about you, but it seems almost

every player in this space has proved themselves incapable of holding data in a secure fashion. That includes central government departments, local government and our police forces. After all, every policeman is honourable and decent, right?

The recent huge data thefts from big-brand telcos show how naive it is to believe that these companies can hold our data in a secure fashion. I could point to Amazon and PayPal as companies that have done a pretty good job so far, but maybe that's only by luck.

Both Theresa May's mass-surveillance society and our economy are predicated on the collection of insane amounts of data, and the holding of that is the real issue. There is a huge missed opportunity whereby the incoming legislation could have been tempered by swingeing fines against those to whom we entrust our data, and are then shown to be untrustworthy. If it was, say, £10,000 minimum per person per incident, then companies would invest in proper security precautions, and it wouldn't be possible for a few teenage

script kiddies to dive headlong into a company such as TalkTalk. Companies losing my data will do me more damage than GCHQ (wrongly) deciding that I'm a Russian spy.

And what about virtual private network tunnelling? A number of companies offer these, including F-Secure with its Freedom product. Want your phone to appear on the internet in New York? That's a finger click.

Or Paris? Los Angeles? If you tunnel all of your

traffic over a VPN, then there is nothing for the UK ISP to record. So where does Her Majesty's Government go next? To a foreign company to force them to open up their VPN tunnelling protocols? Is that realistically going to work? What if I rent a VPN end point from a company, and use open-source VPN client technology? Just how is this going to play out?

Of course, the answer will be simple – the government will use its standard toolkit, where everything can be hit by a large hammer. I can't see VPNs being allowed in the long term for home users. It's as simple as that. And if you're a business, just wait until you have to register your infrastructure (and backdoors) with the Home Office.

Remember, command and control is a very long-term project. The government can use as much of our money to control us as they wish. After all, we voted for them. Didn't we?

“The recent huge data thefts from telcos show how naive it is to believe they can hold our data in a secure fashion”

■ Jon Honeyball is contributing editor of *PC Pro*. He's looking for an IBM Selectric "golf ball" typewriter and a few homing pigeons. Email jon@jonhoneyball.com

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